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VOCATIONAL AND INDUSTRIAL SCHOOLS

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DRAWING FOR BUILDERS

A PROBLEM COURSE IN ARCHITECTURAL DRAWING

By

R. BURDETTE DALE, M.E.

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FIRST EDITION
FIRST THOUSAND

NEW YORK:
JOHN WILEY & SONS, Inc.
London: CHAPMAN & HALL, Limited
1916

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PREFACE

THIS book is intended to serve as a basis for a problem course in elementary architectural drawing, and to be especially useful to the practical builder and to the ambitious young man who wishes to become an architect's draftsman. It should also be of service to carpenters and woodworkers in general, and to builders in brick and tile construction. Its aim is not only to teach the student to make drawings, but to instruct him to read and use them. It is written for use in home-study instruction, either with or without assistance, and it is hoped that it may find a place in high schools, vocational schools, night schools and industrial classes.

The text has purposely been made brief so that the reader will not be burdened with an undue amount of material. The directions are explicit but not minute, reliance being placed upon the ingenuity of the student to guide him over the less difficult points. Illustrations are used freely, as they are frequently more effective than the text.

The problems are intended to be something more than mere copy work and they are stated in increasing degrees of difficulty. Enough material is presented so that some choice may be made by the instructor in outlining a course. Only enough of the line exercise work and of the elementary principles of projection is presented to familiarize the student with the main principles of the theory of drawing, the emphasis being placed rather upon practical problems of more interest to the student. The drawings are only slightly reduced from the originals and, while they are not perfect, they may be used as a standard toward which the student should look as a practical ideal.

To carry on the work with the best success the student should have some knowledge of building construction. This may be cultivated by observation and study. It is suggested that instructors take their classes on inspection trips to buildings under construction, as much valuable information may be gained in this way. As a reference book on building construction, the reader is referred to

Greenberg and Howe's *Architectural Drafting* in the Wiley Technical Series. He should also be provided with a copy of the *Official Moulding Book*, which may be obtained free from any sash and door factory or planing mill.

If the students are carrying on a course in manual training simultaneously, many of the projects may actually be constructed in the shops, thus correlating shop work and drawing very effectively.

The author will gladly cooperate with anyone using this book.

R. Burdette Dale.

Ames, Iowa,
June, 1916.

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DRAWING FOR BUILDERS

CHAPTER I

INTRODUCTION

1. The ability to make and use a good drawing is as important for builders as it is for any other class of mechanics. Every worker in wood and other materials used for building purposes must have in mind a definite idea of the structure which he is about to make, if he is to do his work efficiently and well. No better way is known for accomplishing this than to make a drawing of the proposed structure. It is well to begin with the more simple and easily understood drawings and pass on to the more complicated ones as the skill of the draftsman is developed. In other words, it is best to begin at the bottom. Furthermore, in order that the drawing shall be neat, accurate and intelligible some attention must be given to the technique of drawing, to the accuracy of line and curve and to an understanding of the common conventions of projection.

2. A Drawing; What it is for. A drawing is a picture or graphic representation of an idea or an object. A drawing is a system of lines by which various arrangements and methods may be studied and the best plan adopted. It is also a method of recording and conveying information. Just as information may be conveyed by word of mouth and received by the ear, so a drawing conveys information which is received by the eye. A drawing is seldom intended for the eye of the maker alone, but by means of the drawing he intends to convey information to others. In this respect the art of drawing may be said to resemble a graphic language.

3. Kinds of Drawing. There are, in general, two kinds of drawing. The first kind is the one with which we are most familiar and is similar to the effect obtained if we photograph the object. This kind of drawing is called *perspective drawing.* It is very interesting and useful, but for the purposes of the mechanic it is of small value for the following reasons: The object is not seen in its true size, or in any definite ratio to its true size, since lines of equal length frequently do not appear to be equal in the drawing. The true shape of the object is not indicated in the drawing because of space relations. For example, a true circle appears as an ellipse except under certain well defined conditions. It is difficult to properly dimension a perspective drawing so that the mechanic may know what size to make the object. Moreover, it is more or

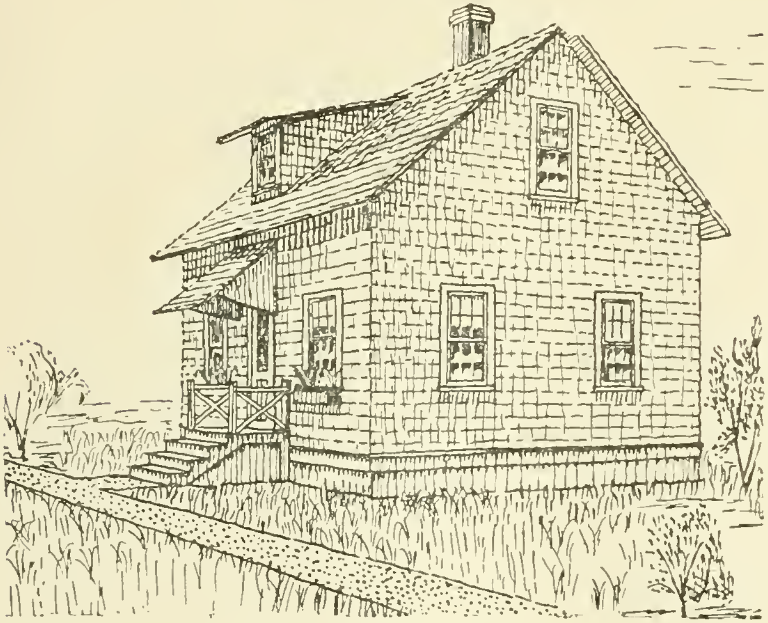


FIG 1.—Perspective View of a Cottage.

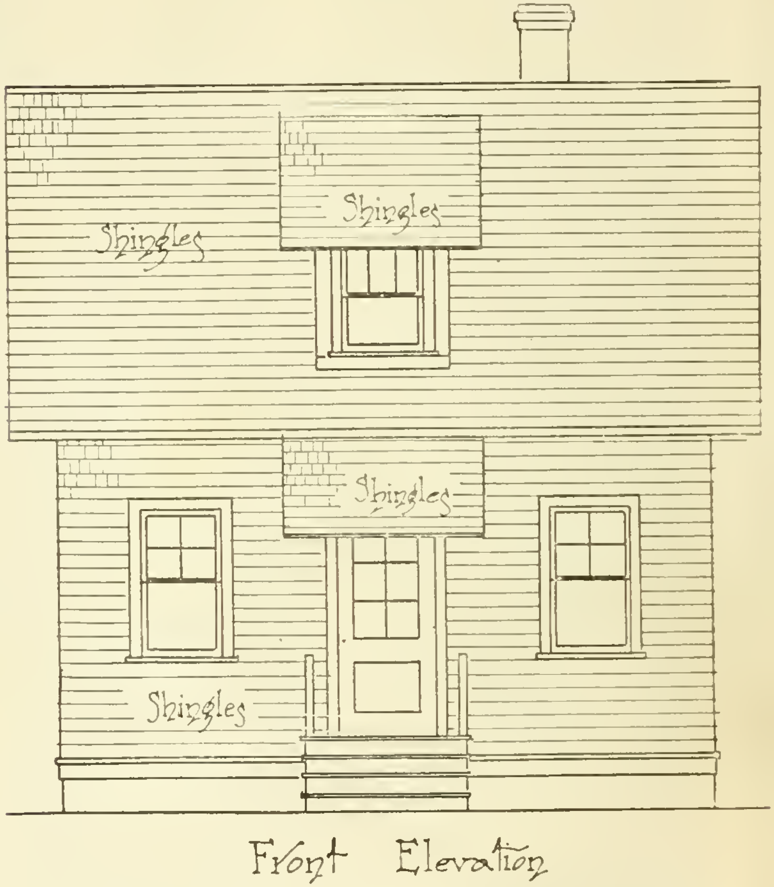


FIG. 2.—Front View of Cottage in Straight-line Projection.

less difficult to make such a drawing. An illustration of a perspective drawing of a cottage is shown in Fig. 1.

The other kind of drawing—the kind most used by the mechanic and in which we are most interested—is *straight-line projection*. Another name for it which means the same thing, but which is not so easy to remember, is *orthographic projection*. In this kind of drawing the object is shown in its true shape and size, or in a given, definite ratio, to its true shape and size. A drawing in straight-line projection may be properly dimensioned for the mechanic and is easily made. An illustration of straight-line projection, a drawing of the elevation of the cottage of Fig. 1, is shown in Fig. 2.

4. A Detail Drawing. A *detail drawing* or *shop drawing* or *working drawing*, as it is variously called, is a representation of an object in straight-line projection for the purpose of giving all of the information necessary for the making of that object. With such a drawing in his hands, the mechanic may proceed with his work and the result will be exactly the thing that was expected by the designer.

In the factory or mill, the mechanic must be provided with a shop drawing before he can proceed with the actual making of the piece. The foreman might, it is true, tell the workman by word of mouth just what is expected of him, but such a procedure would require so much time and cause so much trouble and so many misunderstandings, that it is not usually followed. In like manner the architect might inform the builder by written or spoken word just how the building is to be built. If this scheme were tried it would soon be found that certain things could not well be described by speaking or writing. It is important, therefore, that the workman should know what a detail drawing is and be able to use it intelligently.

5. Reading a Drawing. Some people have difficulty in reading a drawing. A drawing is to them an unintelligible mass of lines and figures. Some drawings may easily be understood while others require study. There is no reason why everyone cannot learn how to use a drawing. The best way to learn how to read a drawing is to learn how to *make* a good drawing. This requires practice and it is hoped that those who study the pages that follow and who make the drawings for which directions are given, will soon acquire the skill both to make and to read detail drawings.

CHAPTER II

DRAWING INSTRUMENTS AND MATERIALS

6. Drawing Equipment Required. It is true that a good draftsman can make a good drawing with poor tools and equipment. It is also true that a poor draftsman will make a poor drawing no matter how complete his equipment. Tools do not make the master-workman. However, it is a pleasure to own and to use good tools and the draftsman takes great pride in his equipment.

For the work of this course only a modest outlay is required. The following is a list of the minimum equipment needed:

1 set of Drawing Instruments in a case, consisting of: 1 Dividers, 5½″; 1 Compass, 5½″, with pencil leg, pen leg and extension bar; 1 Bow Pen, 3″; 1 Bow Pencil, 3″; 1 Bow Dividers, 3″; 1 Ruling Pen, 8″.
1 Drawing Board, about 22″×24″.
1 T-square, 24″ with transparent edges.
1 Triangle, 7″, 45°, transparent.
1 Triangle, 9″, 30°–60°, transparent.
1 French Curve, transparent.
1 Architect's Triangular Scale, 12″, boxwood.
1 2H Pencil for lettering.
1 4H Pencil for drawing.
1 Pencil Pointer of sand paper.
1 Pencil Eraser, " Ruby."
1 Erasing Shield.
1 Art Gum
1 Penholder and assortment of ½ dozen steel pens.
1 dozen Thumb Tacks.
1 bottle Waterproof Drawing Ink.
2 dozen sheets " Standard " or " Normal " Drawing Paper, 9″×12″.

7. Cost of Equipment. The cost of this equipment varies considerably with the quality of instruments chosen. A good set of instruments in a case can be bought for about five dollars and an excellent set for ten or twelve dollars. The remainder of the equipment would cost about five dollars, so that the total cost would probably be between ten and twenty or twenty-five dollars. The student is advised to get the best equipment he can afford. Good instruments will last much longer than poor ones and give much better satisfaction in use.

8. Drawing Board. The drawing board should be made of carefully selected white pine, free from knots and other imperfections. The boards are built up of narrow strips carefully fitted and glued together. To prevent the effects of warping in the larger sizes the back of the board is grooved to a depth of about one-fourth of the thickness of the board and ledges of hardwood are fastened on with screws as shown in Fig. 3. In the smaller sizes this is not usually necessary.

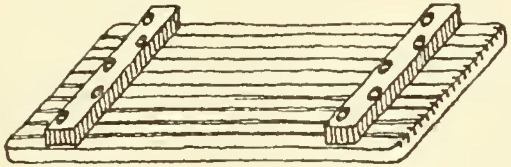


FIG. 3.—Drawing Board with Grooves and Ledges.

In use, the drawing board is placed in a convenient position on the table and the drawing paper is attached to the board with thumb tacks. The light should come from the left or from the front, but a glare in the eyes should be avoided. A comfortable stool should be provided, though many draftsmen prefer to work in a standing position, as this allows more freedom of motion.

When not in use the drawing board should be laid on a flat surface or placed on edge in such a position that it will not be subject to excessive heat or to sunshine, as heat would cause it to warp.

9. Drawing Pencils. Pencils for drawing are made of carefully selected leads of several degrees of hardness. While it is true that any good pencil may be used for drawing, yet the special drawing pencils are the most satisfactory.

For lettering, arrow-heads and figures, a 2H pencil having a conical point is the most suitable. For drawing lines, a 4H pencil with a chisel point is satisfactory, although some draftsmen prefer a harder pencil. The chisel point does not wear away so rapidly as the conical point.

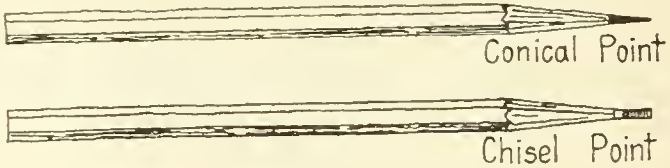


FIG. 4.—Pencil Points.

In sharpening a drawing pencil the wood is first carefully cut away with a sharp knife and the lead is then brought to a point with the sand paper pointer. Fig. 4 shows a conical pencil point and a chisel point.

10. Drawing Paper and Tracing Cloth. There are many different grades and kinds of drawing paper available. It is a waste of time and effort to make a good drawing on poor paper. *Detail paper* is a paper usually of a cream color which is intended mostly for pencil work. "Duplex" detail paper is an excellent grade which is suitable for either pencil or ink work. It comes in rolls or by the sheet. The sheet sizes are 19″×24″, 22″×30″, or 24″×36″ and the rolls are 30″, 36″, 42″, 56″ or 62″ wide. "Standard" or "Normal" papers, which are recommended, may be obtained in tablet form or loose sheets 9″×12″ in a strong manila envelope. This size will cut conveniently to $8\frac{1}{2}''\times11''$, which is the standard size for this course.

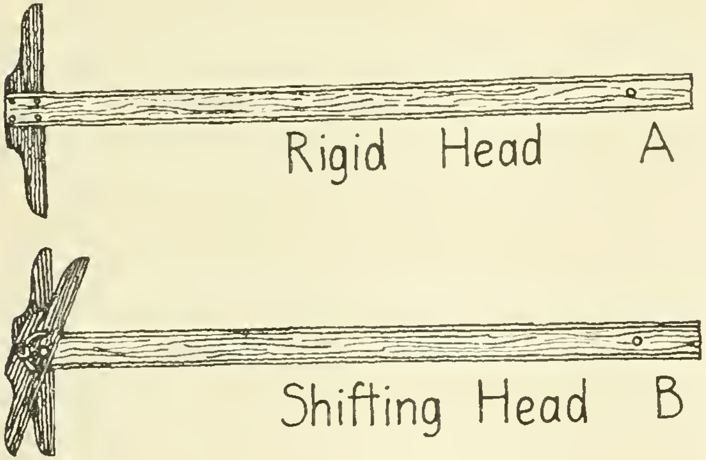


FIG. 5.—T-squares with Rigid and Shifting Heads.

Tracing cloth is used to trace the pencil drawing on with ink. It is a prepared and varnished cloth which is highly transparent. One side is usually glazed and the other side is dull. It comes in rolls 30″, 36″, or 42″ wide, or it may be had in sheets on special order. Special directions for tracing will be given later.

11. The T-Square. The T-square may be made of pearwood, maple or mahogany with ebony or celluloid lining on the head and blade. The head may be either rigid, as shown in Fig. 5 (*A*), or shifting, as shown in Fig. 5 (*B*). The shifting head is useful in adjusting the T-square to work already attached to the board without the necessity for taking the drawing up and resetting it.

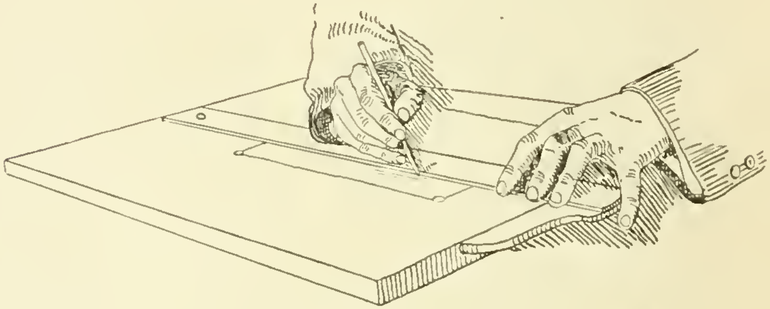


FIG. 6.—Drawing Horizontal Lines with the T-square.

For drawing horizontal lines the T-square is used as shown in Fig. 6. The head is held against the left edge of the board with the left hand and the right hand is used for drawing the line. In drawing the line the pencil is moved to the right. The upper edge of the T-square is used to guide the pen or pencil. By sliding the T-square up or down along the left edge of the board a line may be drawn in any position.

When the T-square is not in use it should be laid flat, or hung in a vertical position to prevent warping.

12. The Triangle. Triangles are made of wood, hard rubber or celluloid. Celluloid triangles are preferred on account of their transparency and cleanliness. For the purposes of this course two triangles are necessary: one which measures 7″ on each leg and the third side of which makes an angle of 45° with the other sides as shown at *A* in Fig. 7, and one which measures 9″ on the longer leg and the third side of which makes an angle of 30° with one leg and 60° with the other as shown at *B* in Fig. 7.

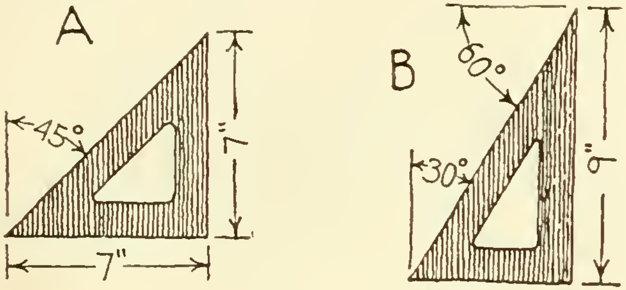


Fig. 7.—45° and 30°–60° Triangles.

Triangles are used in connection with the T-square or with each other for drawing lines at given angles with the horizontal. In Fig. 8 is shown the method of drawing a vertical line, which is a line that makes an angle of 90° with the horizontal. One leg of the triangle is held firmly in contact with the upper edge of the T-square, while the vertical edge is used as a guide for the pencil or pen. In drawing the line the pencil is moved upward away from the body.

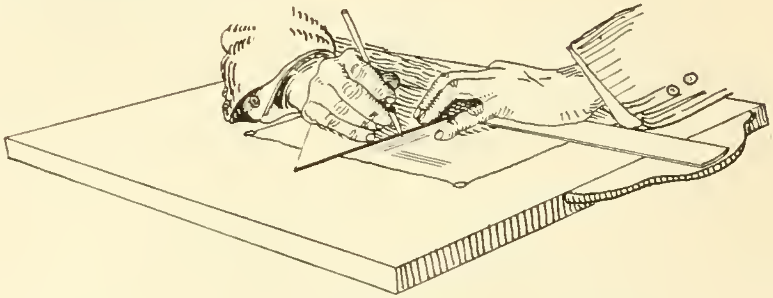


Fig. 8.—Drawing Vertical Lines with a Triangle.

The method of drawing a line which makes an angle of 45° with the horizontal is illustrated in Fig. 9. The triangle is held firmly in contact with the upper edge of the T-square and the edge of the triangle is used to guide

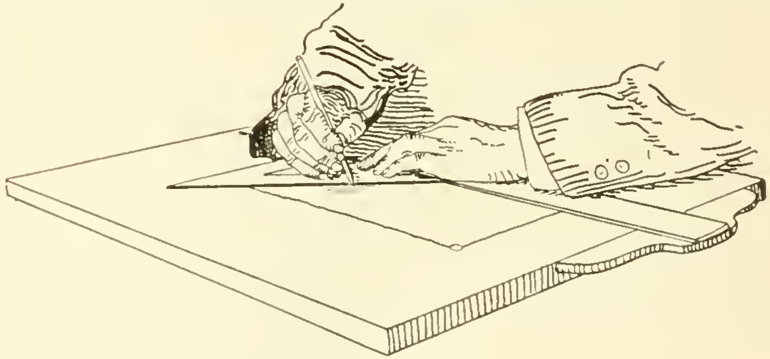


Fig. 9.—Drawing a 45° Line with a Triangle.

the pencil. In drawing the line the hand is moved upward and away from the body.

The methods of drawing lines making other angles than those already mentioned are shown in Figs. 10, 11, 12, 13 and 14. These figures are for the most part self-explanatory. The pencil is moved in the direction of the arrow in each case. With practice the student will soon be able to chose the most convenient arrangement of T-square and triangles for any desired combination of lines.

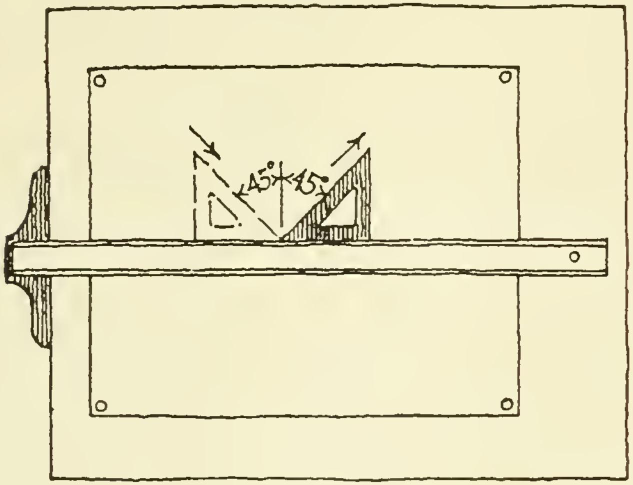


Fig. 10.—Drawing 45° Lines.

When not in use triangles should be laid flat or hung in a vertical position for the reason that they are liable to warp.

13. The Irregular Curve. The irregular curve or the French curve is shown in Fig. 15. It is used as a guide for drawing curves that are not arcs of circles or for which the compass cannot be used. It is made of wood, hard rubber or celluloid, but the celluloid curve is to be preferred.

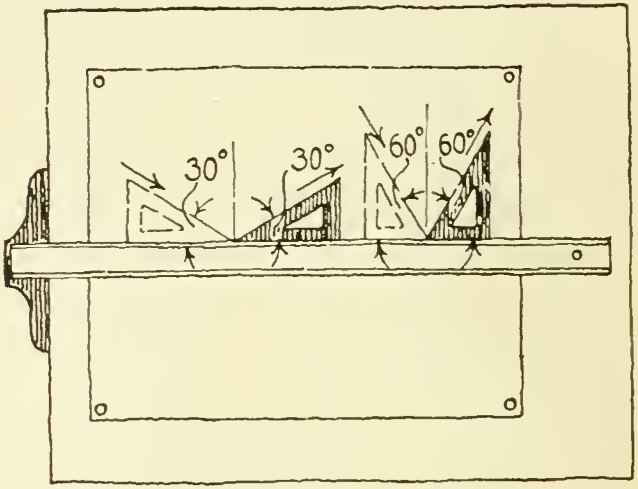


Fig. 11.—Drawing 30°-60° Lines.

An irregular curve is usually determined by a series of points. It is then necessary to join the points with a line drawn free-hand to form a smooth curve. The French curve is then fitted to the line or portion of it. Special care is necessary in order to avoid humps or irregularities in the line. In fitting the French curve to the line it is well to make sure that the direction of increasing curvature is the same in both the instrument and the line. The entire length of the fitted portion is not drawn at each setting, but a new setting is made so that the fitted portions will overlap, thus insuring a smooth line.

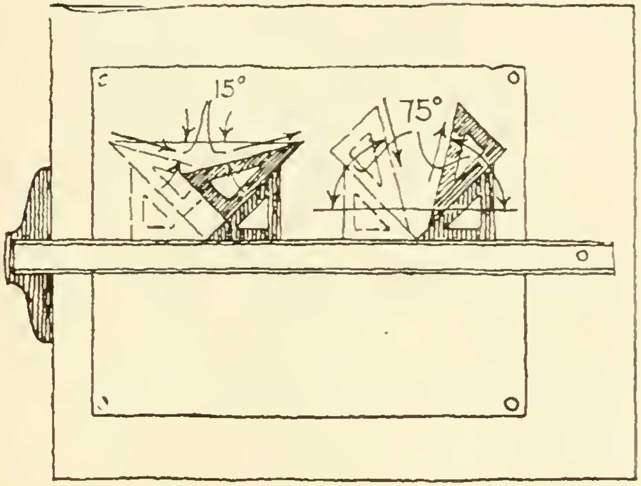


Fig. 12.—Drawing 15°–75° Lines.

Lay the instrument down in different positions until a portion of the edge exactly coincides with a portion of the curve to be drawn. Now draw a part of the curve with which the edge coincides but do not draw your line the full distance of the coincidence. When setting the instrument again to complete another portion of the curve, the edge should be made to coincide with a part of the curve already drawn. This point is illustrated in Fig. 16. If the radius of curvature is small it will probably be better to use a compass for this portion of the curve. The beginner will find that a great deal of practice is required before the French curve can be used successfully.

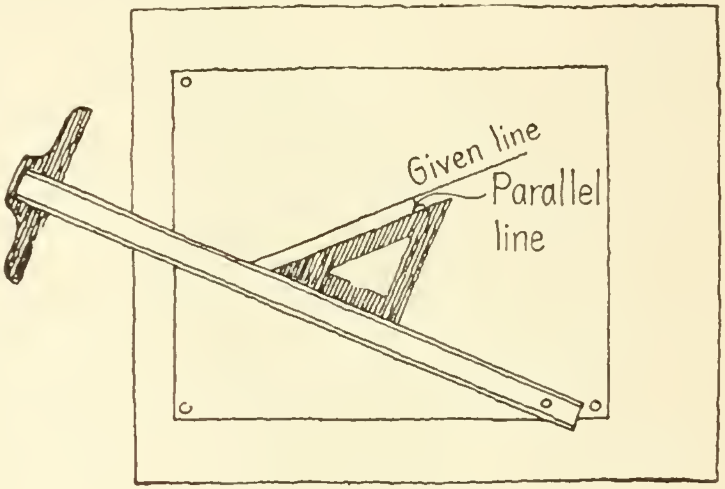


Fig. 13.—Drawing Parallel Lines.

Precautions should be taken to prevent the French curve from warping when it is not in use.

14. The Architect's Scale. Nearly everyone is familiar with the ordinary foot rule and knows that building measurements are taken in feet and inches, and halves, quarters, eighths and sixteenths of an inch. It is not always possible to make a drawing the full size of the object, however, because the drawing would be too large for convenience. Large drawings are difficult to handle, especially when used on a building which is under construction, because of wind and weather. For this reason the drawings are frequently *scaled down* from the actual size of the object, and for this purpose the architect's scale is used.

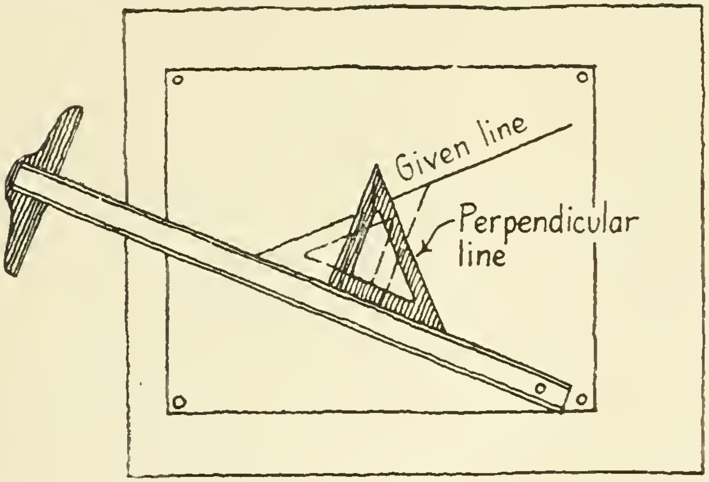


Fig. 14.—Drawing Perpendicular Lines.

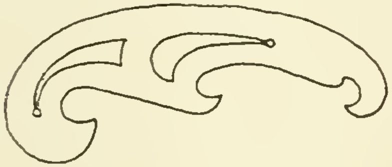


Fig. 15.—The French Curve.

The architect's scale is usually made of boxwood and is either flat or triangular in shape, as shown in Fig. 17.

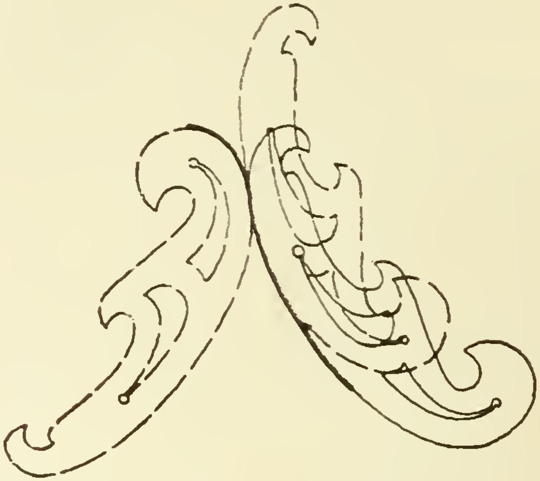


Fig. 16.—Using the French Curve.

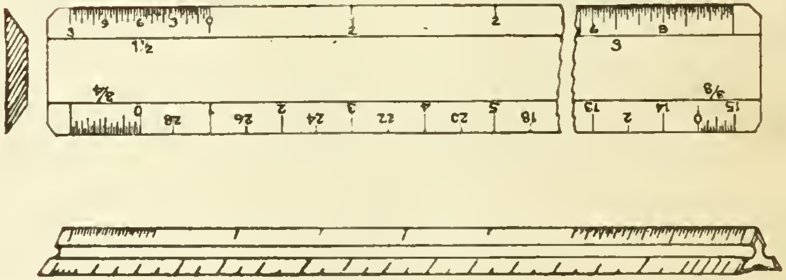


Fig. 17.—Flat and Triangular Scales.

Scales which have white celluloid strips on which the graduations are marked are desirable because they are easy to read. The triangular shape is popular because it has a large number of graduations on the same scale, but the flat scale is less confusing in use.

A desirable series of graduations for a flat scale are $\frac{1}{8}''$, $\frac{1}{4}''$, $\frac{1}{2}''$ and 1″ to the foot. If the $\frac{1}{4}''$ to the foot scale is used it would mean that $\frac{1}{4}''$ on the drawing would be equal to one foot on the actual object. In other words, the drawing would be one forty-eighth of the full size of the object. This particular scale is often used for house plans and is designated as the *quarter scale,* but it must be noticed that this does not mean *quarter size.* The method of reading the one-inch scale is illustrated in Fig. 18, which should be thoroughly studied.

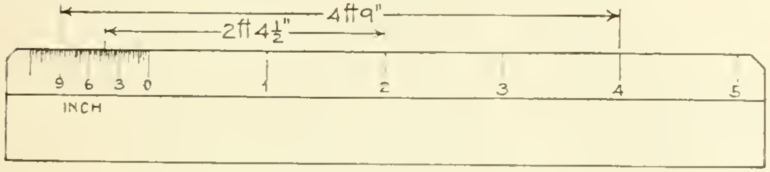


Fig. 18.—Reading the Architect's Scale.

A satisfactory series of graduations for the triangular shaped scale are $\frac{1}{8}''$, $\frac{1}{4}''$, $\frac{3}{8}''$, $\frac{1}{2}''$, $\frac{3}{4}''$, $1\frac{1}{2}''$, 2″, 3″ and 4″ to the foot. In using the triangular scale, the scale guard shown in Fig. 19 is of convenience, as the graduation which is being used is more easily found.

In transferring measurements from the scale to the paper it is customary to lay the scale directly on the paper and mark the required points with a sharp pencil or a needle point.

15. Drawing Instruments. Drawing instruments are made in six or eight different grades and several different styles. For the most part they are manufactured in Germany and Switzerland. The best grades are made of rolled German silver, which is a dense alloy of copper, nickel and tin that is not subject to rust or objectionable corrosion. The cheaper grades are made of cast German silver and the very low price instruments are of brass, nickel plated. German silver is a difficult material to work and unless properly handled and rolled the results are not satisfactory. The cast metal is not dense, but has numerous small holes and does not work successfully. The brass instruments are suitable only for beginners and should not be used by the serious student.

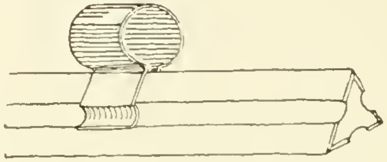


Fig. 19.—The Scale Guard.

If purchased in the set, a case is also usually included. The cases are of two kinds, the pocket case with flaps, as illustrated in Fig. 20, and the bar-lock case shown in Fig. 21.

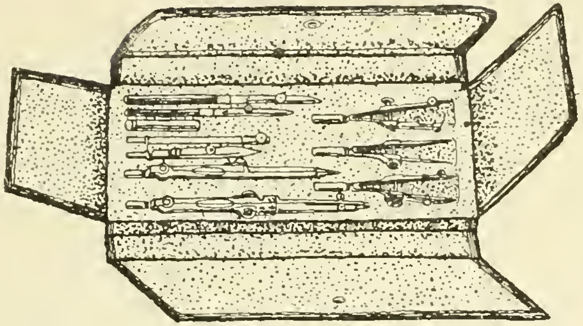


Fig. 20.—Instruments in Pocket Case with Flaps.

16. Styles of Instruments. There is really little choice between the styles of instruments illustrated in Fig. 22.

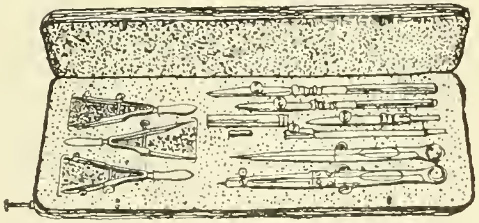


Fig. 21.—Instruments in Bar-lock Case.

While each style has advantages over the others the difference is so slight that the purchaser may satisfy his personal taste.

17. The Compass. The compass which is shown in Fig. 23 is used for drawing circles and circular arcs. For ordinary requirements it should be 5 or 6 inches long. It should be fitted with a pencil leg, pen leg and lengthening

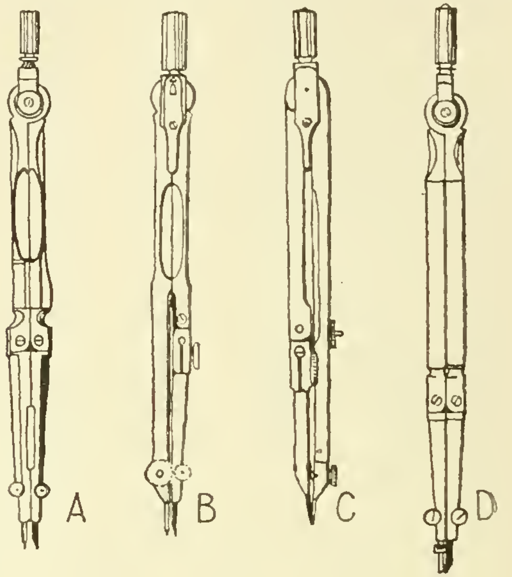


Fig. 22.—Various Styles of Drawing Instruments.

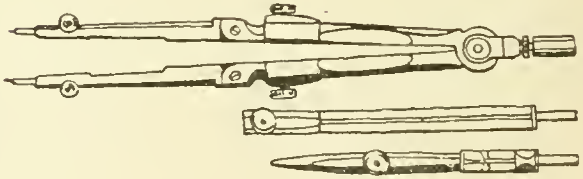


Fig. 23.—The Compass.

bar. The fixed leg usually has an adjustable needle point, one end of which is tapered and the other end of which is provided with a shoulder to prevent the point from making a large hole in the paper. For pencil work a chisel point, obtained by sharpening the lead on a piece of sand paper or a flat file, is best. For ink work the pencil leg is removed and the pen leg substituted. When circles of large radius are to be drawn the lengthening bar may be used.

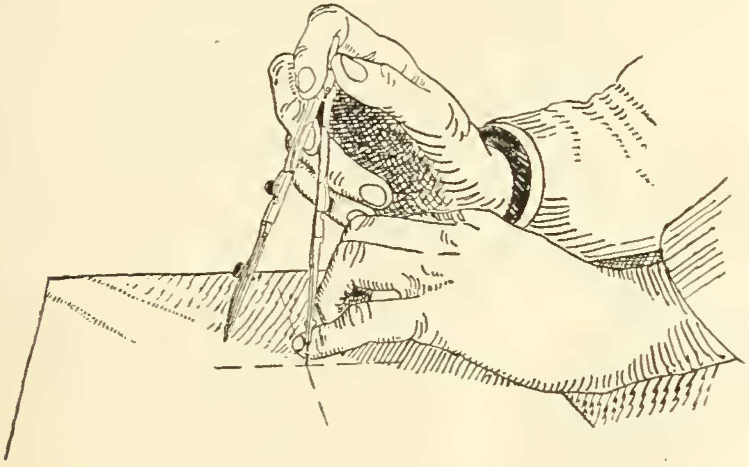


FIG. 24.—Guiding the Needle Point of the Compass.

The method of using the compass is shown in Figs, 24, 25 and 26. The center of the required circle is first located by drawing two lines, one horizontal and one vertical, at right angles to each other. The compass is then set to the required radius and the needle point is guided to the center by the little finger of the left hand, as shown in Fig. 24. The correct method of holding the compass and starting the circle is shown in Fig. 25 and the act of completing the circle is shown in Fig. 26.

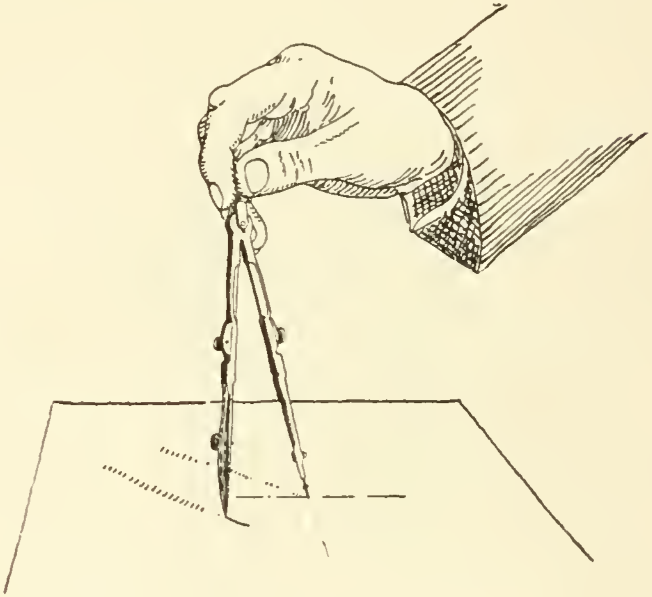


FIG. 25.—Beginning the Circle.

If a circle is to be drawn with a radius of three inches or more, the knuckle joints of the legs should be turned so that the lower portions will be perpendicular to the paper, as shown in Fig. 27. If a circle having a radius of more than five or six inches is to be drawn, the pencil point should be withdrawn and the lengthening bar inserted in the manner illustrated in Fig. 28.

The bow compass is used for circles of smaller radius, for which it is handier than the larger compass. Fig. 29 shows this instrument in use.

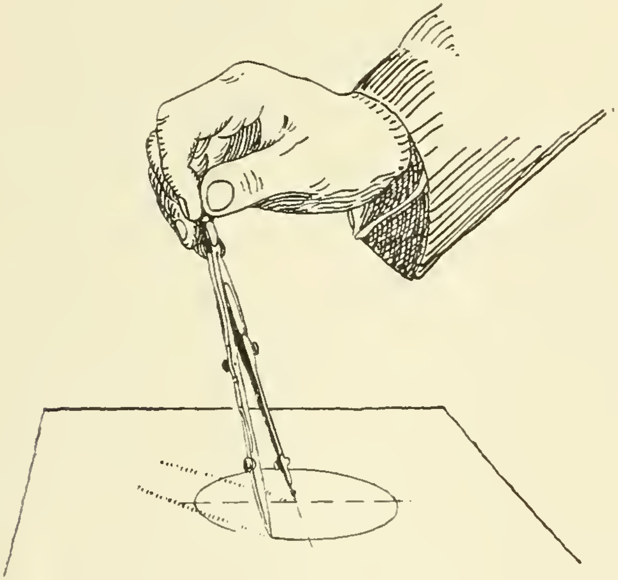


Fig. 26.—Finishing the Circle.

18. The Dividers. The dividers shown in Fig. 30 are used for transferring or stepping off distances. They are also sometimes used for dividing a distance into a given number of equal parts, although the scale is really more efficient for that purpose in most cases. The instrument is generally manipulated with the right hand in the manner shown in Fig. 31. By pressing the thumb and first finger together the points of the dividers may be brought nearer each other, and by separating the second and third fingers the points may be separated. In taking distances from the scale it is best not to prick the points into the face of the scale, but to lay the scale down flat on the drawing board and take the distance off, as shown in the illustration. For close adjustment the hair-spring attachment may be used. In stepping off distances on the drawing,

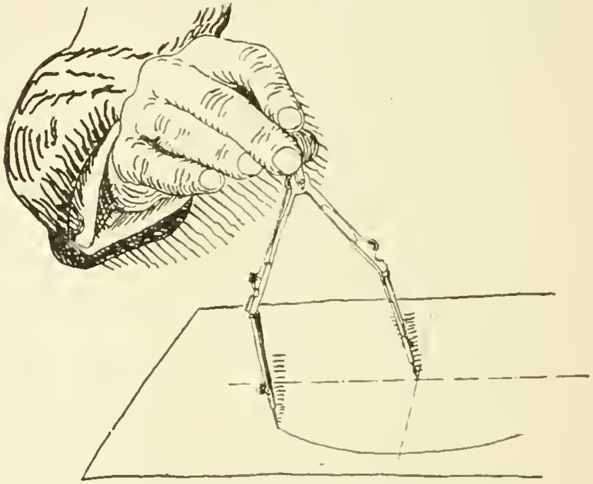


Fig. 27.—Knuckle Joints of Compass in Use.

be careful not to punch unsightly holes in the paper. Do not drop the instrument on the floor, as the points are easily injured. For short distances the bow dividers are more convenient.

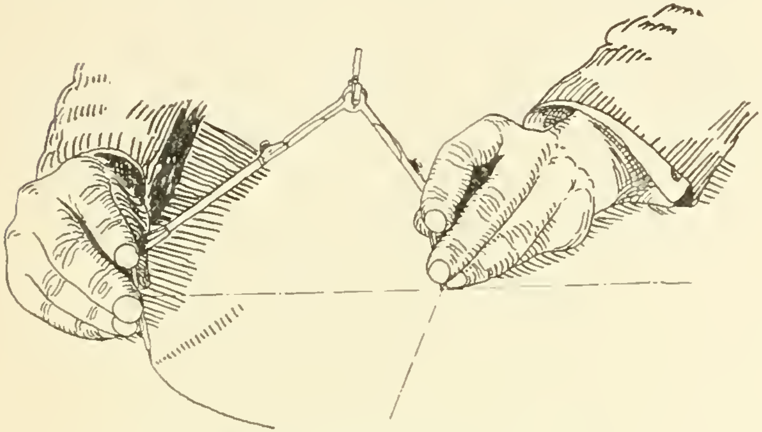


Fig. 28.—Lengthening Bar of Compass in Use.

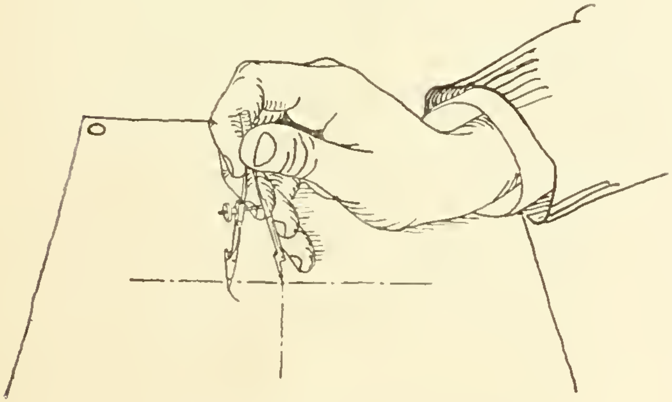


Fig. 29.—Using the Bow Compass.

19. The Ruling Pen. Several different kinds of ruling pens are shown in Fig. 32. The style shown at *A* is the most commonly used. That shown at *B*, called the "click" pen, has the advantage that the nibs may be opened for cleaning and closed again without altering the adjustment. The "wedge" pen shown at *C* has no thumbscrew to obscure the sight, and for this reason it is preferred by many. The Swedish "detail" pen shown at *D* has broad nibs which hold much ink, so that long and heavy lines can be drawn without refilling the pen.

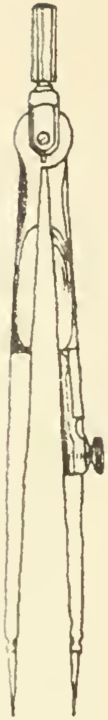


Fig. 30.—The Dividers.

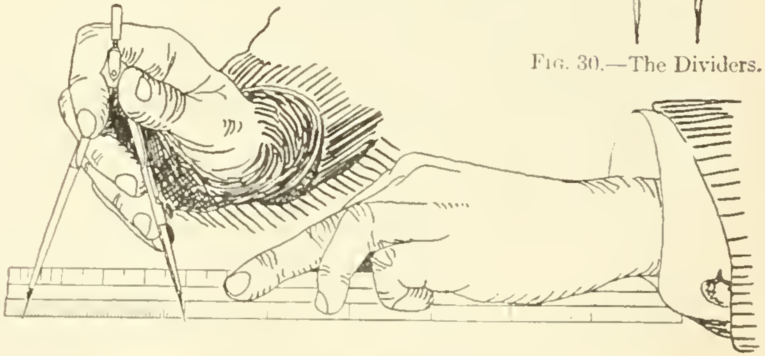


Fig. 31.—Using the Dividers.

To fill the pen with ink the stopper is removed from the ink bottle and the quill is inserted between the nibs of the pen. This operation is shown in Fig. 33. The pen will then become charged with ink. Do not get ink on the outside of the nibs, and do not fill the pen too full. The upper surface of the ink between the nibs should not stand much more than $\frac{3}{8}''$ above the point. Do not hold the pen over your drawing when filling it, as an accident is liable to happen which will cause a blot.

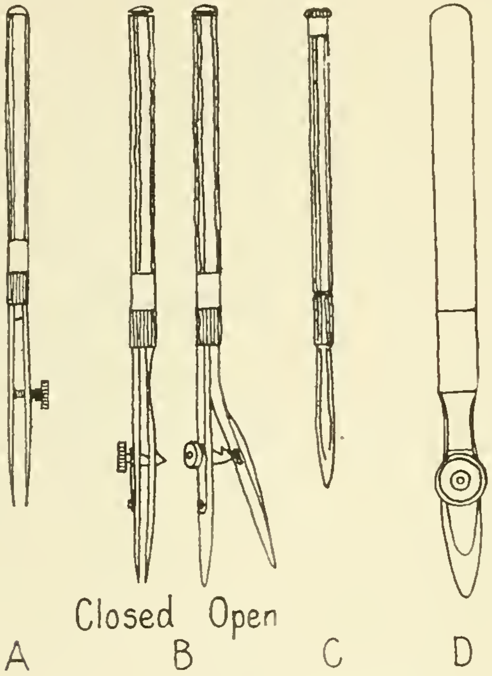


Fig. 32.—Various Styles of Ruling Pens.

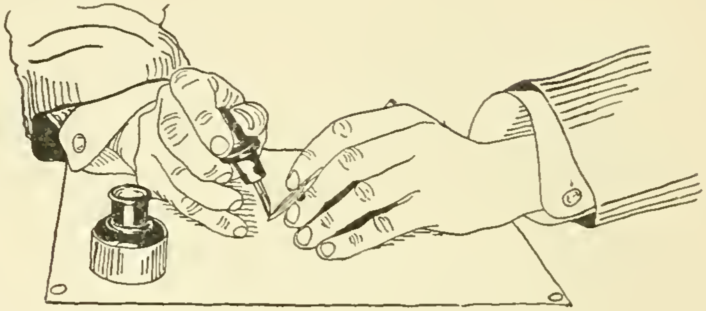


Fig. 33.—Filling the Ruling Pen.

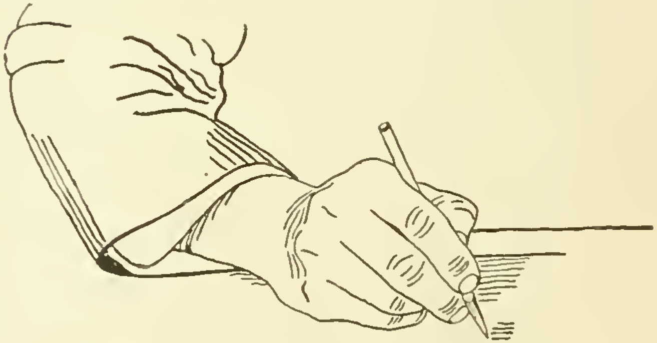


Fig. 34.—Holding the Ruling Pen.

To ink a straight line first make sure that the nibs are set the right distance apart for the correct weight of line. Never try to make a line so thin and fine that the ink will not flow readily from the pen. Lines which are too heavy dry slowly and are hard to manage. A medium weight line is the best to use. Test the setting of the nibs on a separate piece of paper until you are sure that the correct adjustment has been obtained. Guide the pen against the blade of the T-square and move it from left to right. Do not press down heavily or press the pen against the edge of the T-square. A firm hold is all that is required. When the end of the line is reached lift the pen from the paper at once, which will prevent the ink from being drawn out, thus forming a blot.

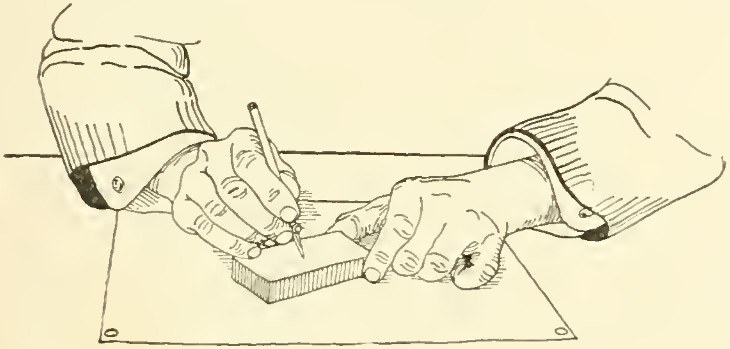


FIG. 35.—Sharpening the Ruling Pen; First Operation.

If the ink does not flow readily from the pen, wipe out between the nibs with a soft cloth and refill. Do not lay the pen down without first wiping out the ink.

20. To Sharpen the Pen. After continued use the pen is quite likely to become dull. It will then cease to work properly and must be sharpened. A close-grained oil stone is best for this purpose. Hold the pen perpendicular to the surface of the stone with the point resting on the stone. Move the pen back and forth with a rocking motion in a direction parallel with the flat of the nibs. Examine the point frequently and stop the operation as soon as the nibs are nicely rounded and of even length. This part of the operation is shown in Fig. 35. It now remains to bring the points of the nibs, which were made blunt by the previous operation, to an edge. For this purpose the pen is inclined to the stone and stroked back and forth, at the same time giving a twisting motion to the handle of the pen. This operation is shown in Fig. 36. The ends of the nibs must not be sharpened to such an extent that they will cut the paper or tracing cloth.

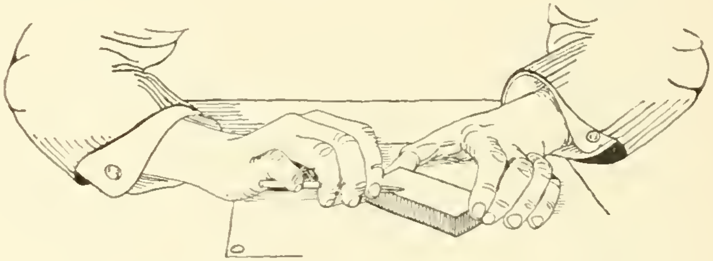


FIG. 36.—Sharpening the Ruling Pen; Second Operation.

21. The Care of Drawing Instruments. Drawing instruments are delicate and must be handled carefully. Do not jab the points into the drawing board or throw the instruments around carelessly. Do not oil either the main joints of the compass or dividers or the knuckle joints. Do not allow a crust of ink to accumulate between the nibs of the pens. Should such a crust occur do not scrape it out with a knife blade but rather wipe it out carefully with a moistened cloth or chamois. Keep all your drawing appliances clean and free from dust by wiping them frequently with a soft cloth. If the instruments are to be laid aside for a time, wipe them with an oily cloth to prevent rust and corrosion.

CHAPTER III

HOW TO MAKE A DRAWING

22. The Mental Picture. The first consideration in the making of a drawing is for the draftsman to have in his mind a mental picture of the drawing which he wishes to make. Just as in everyday life one cannot say sensible things unless one has a clear mental conception of the idea which he desires to express, so in making a drawing one must also have a clear idea of the object which he proposes to represent. Drawing is a language and the draftsman must be able to make use of it as such. The usual conventions must be recognized and the technique of this language must be followed. While it is possible for the beginner to make a fairly presentable drawing by hit or miss methods, he will save much time and obtain much better results by studying and following well-established practice. The athlete who would run one hundred yards in ten seconds must perfect his form. The draftsman who would get the best results must also pay particular attention to his form. In this chapter the various steps in the making of a drawing will be taken up and explained in detail.

23. Fastening the Paper to the Board. The first step in starting a drawing is to fasten the paper to the board. With the T-square in its proper position at the left of the board, place the lower edge of the paper in contact with the upper edge of the blade. The left edge of the paper should be within a couple of inches of the left edge of the board, as the T-square is more rigid near the head than it is near the end. Then set thumb tacks in the upper corners of the paper and push them into the wood so that they project as little as possible. Pull or smooth the paper down so that there are no wrinkles or loose spots and secure at lower corners with thumb tacks in a similar manner.

24. Arrangement of Tools. The proper arrangement of drawing tools on the table for efficient work is a matter that requires attention. In order to keep the drawing clean and neat it is necessary to carefully dust or wipe off the drawing tools before beginning work. The tools should then be placed on the drawing table in such a position that they will be within convenient reach. The most convenient position is to the right at the edge of the drawing board. The table should always be orderly in appearance and the tools should never be scattered promiscuously about. If a drawing is to be left on the board it is best to cover the table with paper or cloth to protect the drawing until you are ready to start work again.

25. The Standard Sheet. All of the problems required in this course may be drawn on a standard sheet $8\frac{1}{2}'' \times 11''$. Larger sheets may be used but this is not necessary. The $8\frac{1}{2}'' \times 11''$ size is the same as the customary size for business paper and is neither too large nor too small for convenient use. The proper arrangement of trimming and border lines is shown in Fig. 37. It is to be noticed that a margin 1″ wide is provided at the left so that the completed drawings may be perforated and bound together. A margin of $\frac{1}{8}''$ is left at the remaining edges of the sheet. In the lower right-hand corner a rectangle $1\frac{1}{2}'' \times 3''$ is laid out and in the lower right-hand corner of this rectangle is a square $\frac{1}{2}'' \times \frac{1}{2}''$. In the rectangle provision is made for lettering in the name of the school, the department, the date, the consecutive number of the problem, the student's name and his city. In the $\frac{1}{2}''$ square the catalog number of the course should be given if the work is done in connection with a school. The real title of the drawing together with other pertinent information, such as the scale used and notes as to material, is placed directly under the drawing itself. It is a good idea not to allow any line or letter of the drawing to come closer than $\frac{1}{8}''$ to the border line.

26. Arranging the Views. The beginner is frequently at a loss to know how to arrange the views to get the best results or to decide on the proper scale to use for the best effect. If you would have a carefully arranged drawing you must plan out the relative positions of the different views with reference to the space available. Probably the most satisfactory way to go at this problem is first to

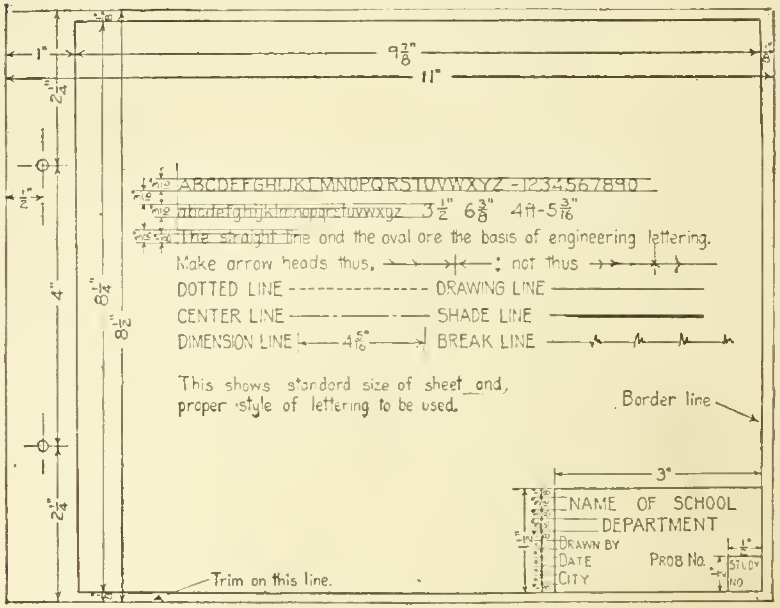

1″
9 7/8″
11″
2 1/4″
1/2″
4″
8 1/4″
8 1/2″
2 1/4″
ABCDEFGHIJKLMNOPQRSTUVWXYZ - 1234567890
abcdefghijklmnopqrstuvwxyz 3 1/2″ 6 3/8″ 4ft-5 3/16″
The straight line and the oval are the basis of engineering lettering.
Make arrow heads thus, ; not thus
DOTTED LINE
DRAWING LINE
CENTER LINE
SHADE LINE
DIMENSION LINE 4 5/16″
BREAK LINE
This shows standard size of sheet and, proper style of lettering to be used.
Border line
3″
NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB No.
STUDY NO
1/2″
Trim on this line.

FIG. 37.—The Arrangement of the Standard Sheet.

sketch in the outline of the views roughly on a separate piece of paper. Fig. 38 shows such a sketch while Fig. 39 shows the finished drawing. After the available space has been determined upon approximately, the scale for each view may be chosen.

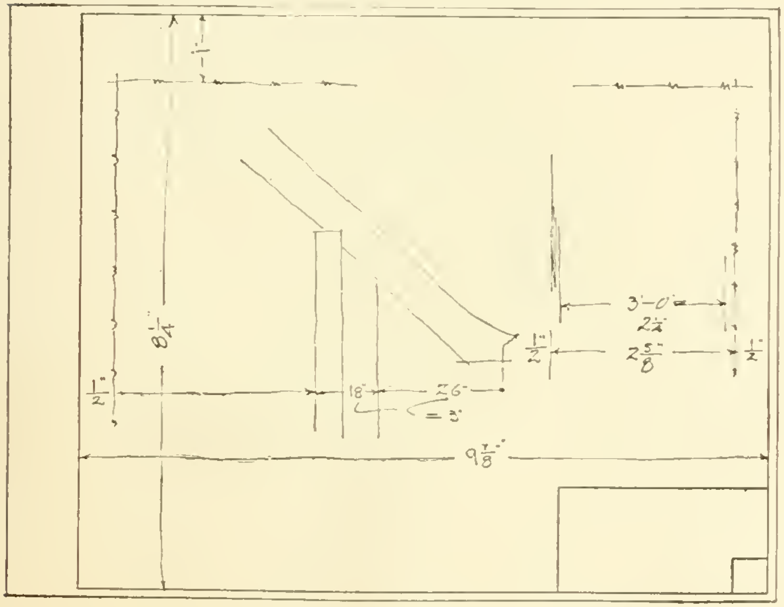


Fig. 38.—Rough Lay-out Sketch of a Drawing.

It often happens in practice that the scale of the drawing is a more important consideration than the size of the sheet. In this case it only remains to trim the sheets to the most convenient size possible under the circumstances. Uniformity of size is always desirable because of added convenience in handling and filing.

The first few problems in the work that follows require that the sheets be divided into six equal squares with a margin $\frac{1}{2}''$ wide between each of them and the border line of the sheet and between the squares themselves. Fig. 40 shows how to proceed with this lay-out. First, draw a light pencil line $\frac{1}{2}''$ from the left-hand border line. Divide the remaining distance into three equal parts by

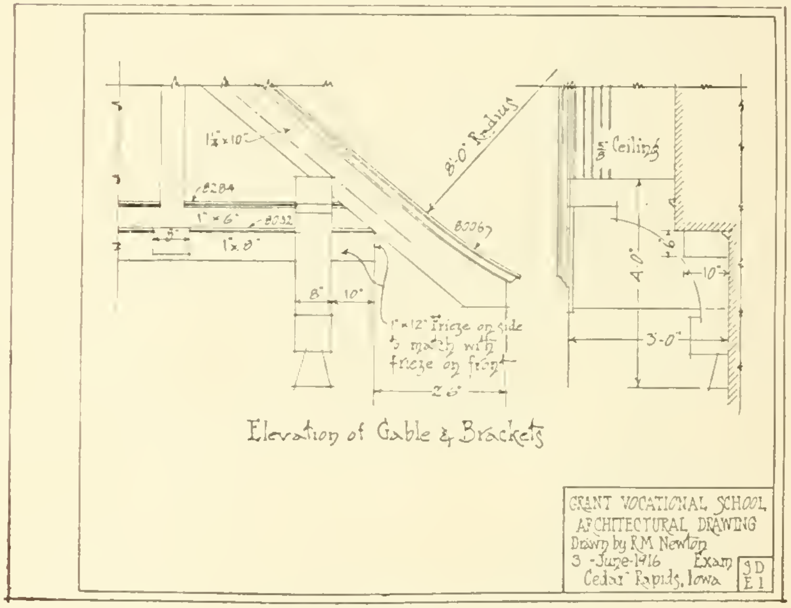


Fig. 39.—The Finished Drawing.

laying the scale diagonally across the sheet, as shown in the figure. Draw vertical lines through these points and lay off $\frac{1}{2}''$ to the left of the right border line and also $\frac{1}{2}''$ to the left of each of the lines just drawn. Lines through these points are the vertical lines of the required squares. A line $\frac{1}{2}''$ below the upper border line gives the upper line of the required squares and it is only necessary to measure off the remaining distances and to draw the required horizontal lines to determine the squares.

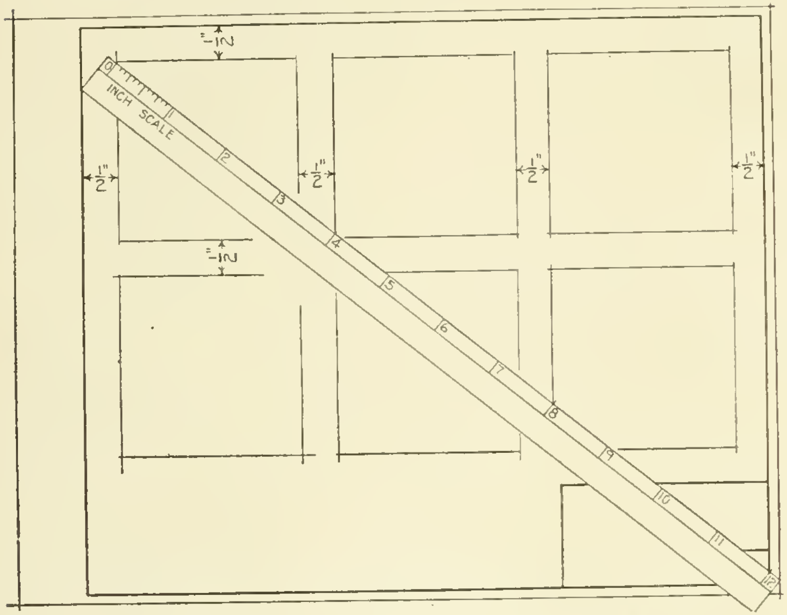


Fig. 40.—Laying-out the Standard Sheet into Six Equal Squares.

27. The Standard Lines. The modern draftsman uses different lines for different purposes. Some of these lines are shown in Fig. 37 and their use is there indicated. A line of moderate weight is used for the outline and visible

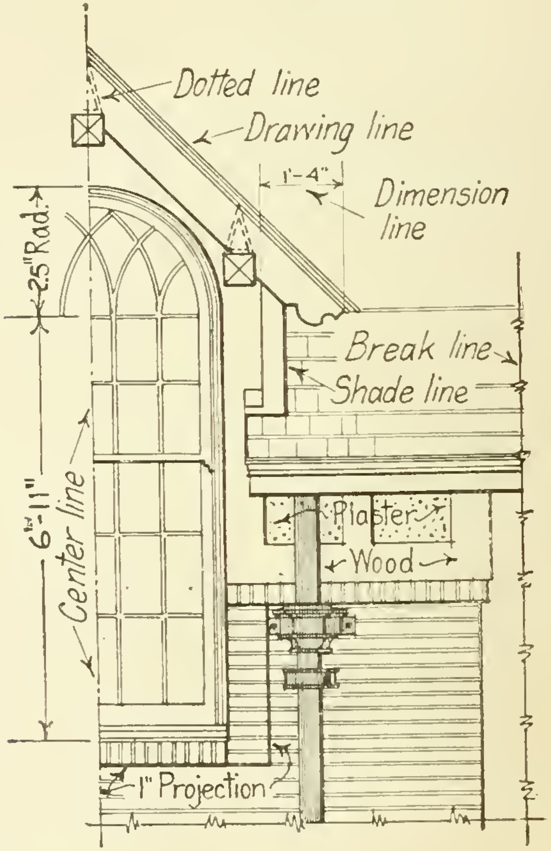


Fig. 41.—Use of the Standard Lines.

lines of the drawing while a dotted line is used to indicate the invisible lines. An alternate dot and dash line is used for the center lines. A comparatively light full line is used for dimension lines. The use of these standard lines is illustrated in Fig. 41.

28. The Pencil Work. After the general arrangement of the sheet has been planned, the drawing itself may be begun in pencil. This work should be done systematically. Do not develop the several views independently but work from one to the other, thus completing the complementary views of the same object simultaneously. Start the work by drawing the necessary center lines upon which to build the views or, should center lines be unnecessary or undesirable, start with the principal lines of the views, such as the horizontal and vertical limiting lines. Then proceed to pencil in the views, using the scale to lay off the correct measurements and projecting these measurements from one view to the next whenever you can. Draw in the dimension lines wherever these are necessary and do not fail to supply all of the required dimensions.

When beginning to learn to make drawings it is desirable that the pencil work shall look exactly like the finished ink drawing will be expected to look, but after you have obtained experience by practice, it is permissible to let the pencil lines overrun somewhat in the interest of speed. A good motto for the beginner is: *Accuracy first and then speed.*

Provide liberally for explanatory notes wherever necessary. It is not always possible to give all the required information in the drawings alone. In other cases a few words of explanation will do away with the necessity for one or more views. Be sure to provide a title for every drawing which will tell clearly but briefly what the object is and the material of which it is made. Indicate the scale of the drawing, if possible, but it is to be understood that the mechanics are to work from the figures rather than from scaled dimensions. Fill in the card in the lower right-hand corner with the information indicated in Fig. 37.

After the drawing has been otherwise completed and the dimensions and explanatory notes supplied, the cross-hatching or section-lining may be put in—not before. If this rule is followed, it will be found possible to omit the portions of the lines immediately around dimensioned figures in the section and thus make them stand out more clearly. The section lines should be uniformly spaced $\frac{1}{16}''$ apart. If more than one kind of cross-hatching is used to indicate different materials, a legend should be provided somewhere on the drawing which tells what the different lines mean.

After the pencil work has been completed in its entirety, it is advisable to look the work over very carefully to see that nothing has been omitted. The drawing should then be submitted to the instructor for his approval before proceeding with the ink work.

29. The Ink Work. It is usually customary to trace the drawing on tracing cloth so that blue-print copies may be made. Practice in inking on the paper directly over the pencil lines is first desirable because tracing is more difficult for the beginner. The ink work should be carried on systematically just as the pencil work was, but with the ink work system is even more necessary. Begin by inking the horizontal and vertical center lines if there are any. Next ink the circles and circular arcs. Draw the horizontal lines beginning with the uppermost and following them down the sheet. Draw the vertical lines in sequence, beginning at the left of the sheet and proceeding to the right. Draw the lines which are set at an angle.

Draw the dimension and extension lines and fill in the correct figures. Ink in the notes and title.

After all the rest of the drawing has been completed line in the cross-hatching with ink. Leave this part of the ink work until the very last.

After the ink work has been completed, examine the drawing carefully for mistakes and corrections. Clean the drawing by rubbing very lightly with art-gum but be sure not to dim the ink lines. Trim it to the correct size and submit it to the instructor.

30. Tracing the Drawing. Tracing cloth is a transparent cloth one side of which has a highly glazed surface, and the other side of which is dull. Some prefer to work on one side of the cloth and some on the other; it is largely a matter of personal choice. If the surface does not take the ink readily, dust it lightly with powdered chalk or talc, and wipe off the excess. A fairly heavy ink line should be used on tracing cloth so that the line will show up clearly in the blue-print. Be careful not to get the tracing cloth wet or to allow water to come in contact with it, as this would spoil the surface for inking.

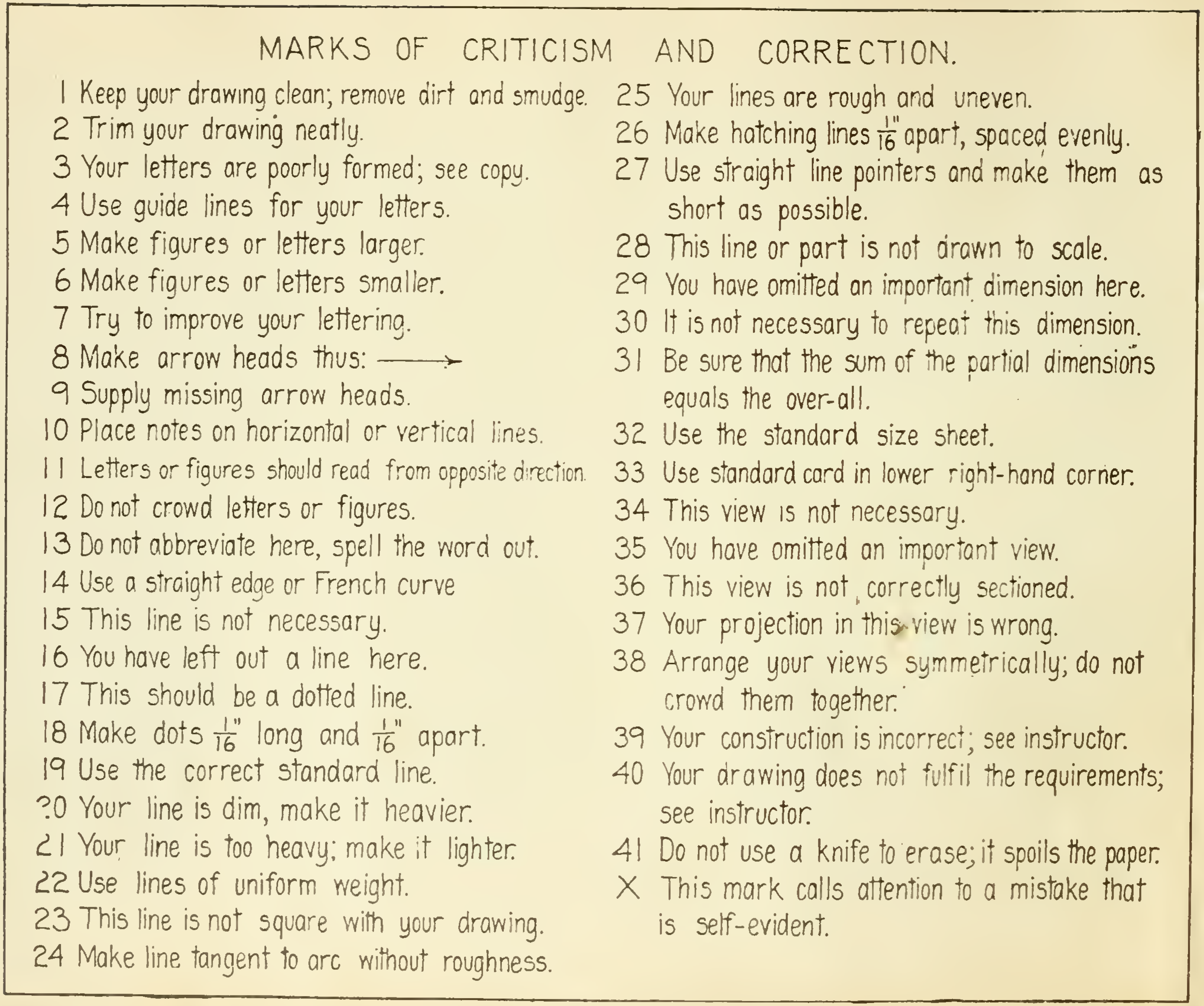
31. How to Erase and Correct a Drawing. In spite of the best one may do it is now and then necessary to erase a portion of a drawing and correct it. The author advises the use of a pencil eraser of soft rubber only for both pencil and ink lines. Such a rubber requires a more liberal application of " elbow grease " than a sand rubber, but there is little danger of injuring the paper or cloth. Do not use a knife to erase ink lines under any circumstances, as the fiber of the cloth or paper is very likely to be injured. If an ink blot should be made accidentally, it is well to take up the undried ink very carefully with a blotter. An erasing shield may well be used to protect the surrounding parts of the drawing. Do not try to make an erasure without first fastening the paper securely to the board with thumb tacks. If the work has been carefully and thoroughly done, the spot may be inked over again without difficulty. It is just as important to learn how to make a neat erasure as it is to learn to draw a line correctly.

32. Efficiency in Drawing. Efficiency consists of two parts, *accuracy* and *speed*, but the most important of these is accuracy. One should, therefore, develop accuracy first and speed will follow. A misleading and inaccurate drawing is worse than no drawing at all. A working drawing, on the other hand, is not intended especially to be an artistic production, and, therefore, no more time or labor should be put on it than is required to make it clear and accurate. The beginner should be especially accurate to the minutest detail at first, but later on he will learn by experience that certain refinements may be neglected for the sake of speed without sacrificing the value of the drawing. For example, at the first the student should not allow his lines to overrun, but after he has gained experience he will find that lines that slightly overrun each other at the corners cause no harm. The mere fact that he does not have to watch his corners so carefully increases his speed. The neatest and best appearing drawing is also likely to be the most accurate for the reason that an orderly mind is the most likely to produce an orderly drawing, and orderliness is attractive.

It is also well, possibly, to remind the student that he cannot do speedy work and look out of the window or talk to his neighbor or otherwise waste his time. The efficient draftsman makes one line follow the other and keeps earnestly at his task until it is finished. If one is truly interested in the work, the matter of efficiency will largely take care of itself.

33. Trimming the Sheet. After the completed drawing has been carefully examined and checked for errors, it should be cleaned and trimmed accurately to size. The sheet may be trimmed by using a straightedge and sharp knife or a regular paper trimmer might be used. Under no circumstances should you use the working edge of your T-square to guide the knife, because an accident will surely occur and a nick will be cut from the edge, thus spoiling it for drawing purposes. Any straight stick may be used and special care should be taken to hold it firmly. It is not best to use the top surface of your drawing board to trim your drawing on, as the knife will scratch through to the board. Be sure to trim all of your drawings accurately to standard size, so that they may all be bound together in book form.

34. Criticism and Corrections. It is a part of the duties of the instructor to offer suggestions and to correct the student's drawings. So many beginners make similar mistakes that it is possible to classify the most common of them. This has been done in Fig. 42. In this list the various items have been numbered in consecutive order, and these numbers may be used to call attention to the corresponding errors on the student's drawing. A student's drawing corrected in this manner is shown in Fig. 43 which illustrates well the method of using these numbers. Before the student submits his drawings to his instructor it would be well for him to look over this list and at the same time examine his drawing to see that he has made



MARKS OF CRITICISM AND CORRECTION.

1 Keep your drawing clean; remove dirt and smudge.
2 Trim your drawing neatly.
3 Your letters are poorly formed; see copy.
4 Use guide lines for your letters.
5 Make figures or letters larger.
6 Make figures or letters smaller.
7 Try to improve your lettering.
8 Make arrow heads thus: ⟶
9 Supply missing arrow heads.
10 Place notes on horizontal or vertical lines.
11 Letters or figures should read from opposite direction.
12 Do not crowd letters or figures.
13 Do not abbreviate here, spell the word out.
14 Use a straight edge or French curve
15 This line is not necessary.
16 You have left out a line here.
17 This should be a dotted line.
18 Make dots $\frac{1}{16}$" long and $\frac{1}{16}$" apart.
19 Use the correct standard line.
20 Your line is dim, make it heavier.
21 Your line is too heavy; make it lighter.
22 Use lines of uniform weight.
23 This line is not square with your drawing.
24 Make line tangent to arc without roughness.
25 Your lines are rough and uneven.
26 Make hatching lines $\frac{1}{16}$" apart, spaced evenly.
27 Use straight line pointers and make them as short as possible.
28 This line or part is not drawn to scale.
29 You have omitted an important dimension here.
30 It is not necessary to repeat this dimension.
31 Be sure that the sum of the partial dimensions equals the over-all.
32 Use the standard size sheet.
33 Use standard card in lower right-hand corner.
34 This view is not necessary.
35 You have omitted an important view.
36 This view is not correctly sectioned.
37 Your projection in this view is wrong.
38 Arrange your views symmetrically; do not crowd them together.
39 Your construction is incorrect; see instructor.
40 Your drawing does not fulfil the requirements; see instructor.
41 Do not use a knife to erase; it spoils the paper.
X This mark calls attention to a mistake that is self-evident.

Fig. 42.—List of Criticisms and Corrections.

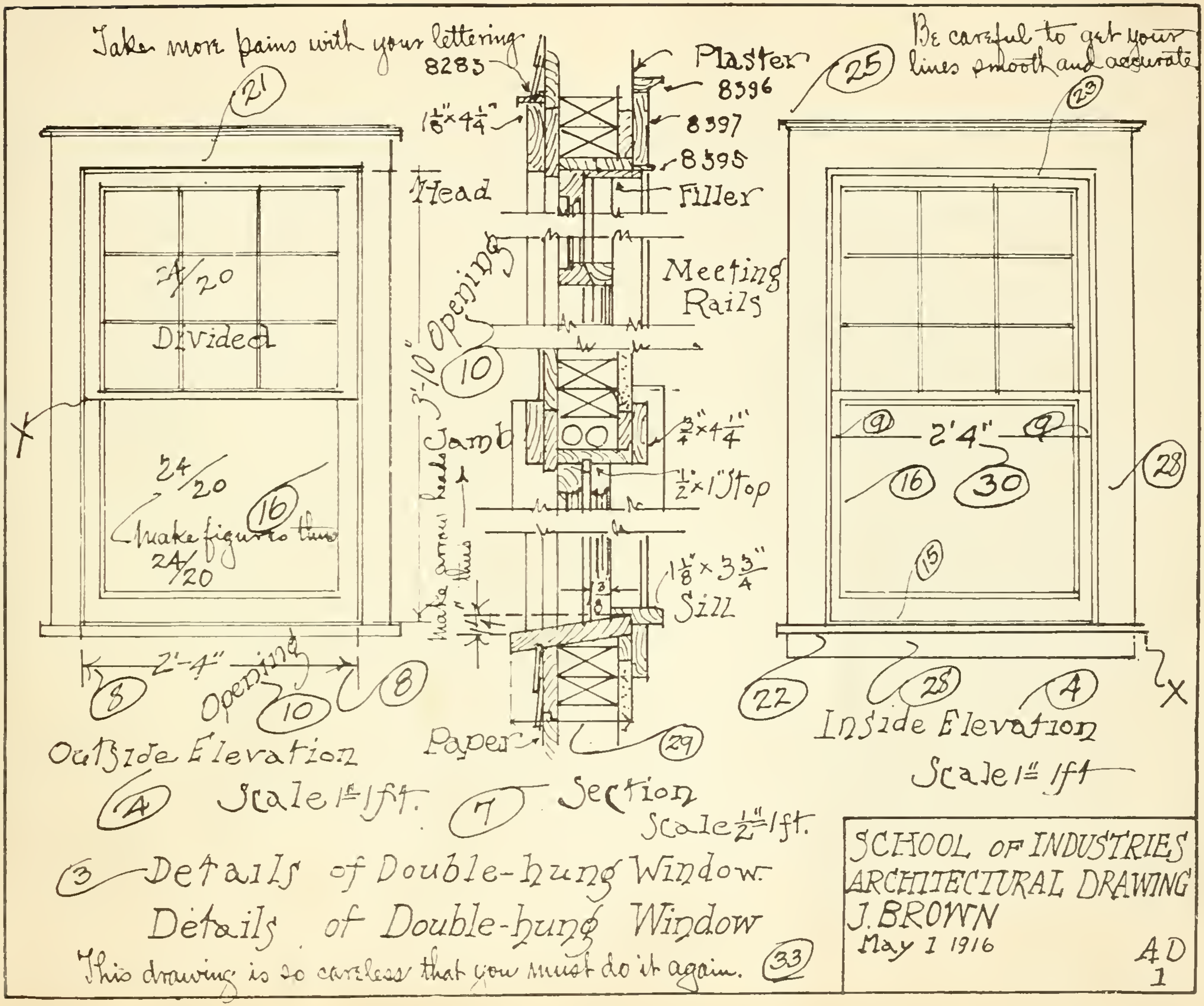


Fig. 43.—A Student's Drawing Corrected.

none of the mistakes listed therein. If the student is working without an instructor this list will give him an easy method of correcting his own drawings. Criticisms are to be taken kindly by the student, as they are not intended to be a personal reflection, but they are the means by which he may bring his ability to a high standard.

35. The Blue-Print Process. Every one should know something about the blue-print process, whereby copies of drawings are made for use on the building and in the field. It is in itself a very simple process and may easily be carried out by anyone with but little experience. The sensitized paper should be purchased already prepared. It is obtainable in rolls ten yards long or longer and 30″, 36″ and 42″ wide at very moderate prices. The solution is made in several speeds, the fastest being " electric-rapid " and the slowest " regular." The electric-rapid is the most economical to use in electric-blue-print machines and will print in thirty seconds or less in bright sunlight. The paper may also be obtained in several weights, the " mailing weight " being the lightest and " thick " being the heaviest.

To make a print one should have a sun-frame and a shallow tray available. The frame should be fitted with polished plate glass for the front and have a hinged removable back. A convenient form is shown in Fig. 44. Place the tracing ink side to the glass and in contact with it lay a sensitized sheet of blue-print paper, yellow side to the tracing. Secure the back to the frame and expose the print to the sunshine for a short time. The period depends upon the speed of the paper and may be determined by trial. Electric-rapid paper should print for about thirty seconds in bright sunlight and the regular speed requires about four minutes' exposure. When the exposure has been completed remove the paper from the frame and immerse it immediately in clear water in the tray. The print should be thoroughly washed for at least five minutes and hung up to dry. If the exposure has been correct and the paper in good condition, the result should be a white-line image on a dark blue background. If the background is pale blue the print has not been exposed long enough, and if the background is grayish blue without white lines or with blue lines the exposure should be shortened.

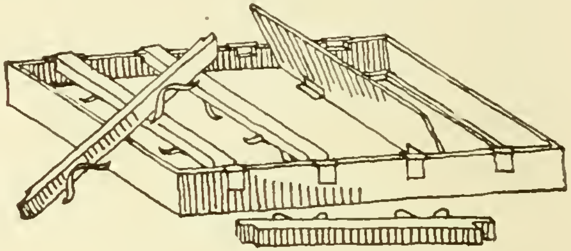


FIG. 44.—A Blue-print Frame.

CHAPTER IV

ARCHITECTURAL FREE-HAND LETTERING

36. Free-hand Lettering. Lettering for architectural drawing, such as we are studying, is usually rendered free-hand, that is, without tools or straight edge. The prime requirement of good lettering is legibility. So far as this requirement is concerned legible handwriting would be suitable, but most draftsmen would not be satisfied merely to write in the dimensions and notes as well as the title on their drawings. Good lettering should be uniform in style and it should also be capable of being rendered rapidly. For this reason simplicity of form is desirable.

The ability to letter well is one of the most difficult things the beginner has to learn. It is largely a matter of careful and painstaking practice. The complaint is sometimes made that this ability is a special accomplishment with which some favored ones are born, but it is common experience that most anyone can learn to do presentable lettering if he is willing to try patiently and conscientiously.

37. Letter Forms and Styles. The forms of the letters as we use them today both in print and as rendered by hand are the result of hundreds of years of development. Before books were printed, manuscripts were laboriously written by hand. This duty was performed by the ancient monks and they took great pride in their work, counting it a labor of love. Out of all this was evolved the alphabet as we know it today.

Inasmuch as this alphabet has a history of more than five hundred years behind it, it would be presumptuous of any of us to attempt radically to change the form of the letters. Many of the attempts to alter and improve the shape and form of the letters made by well-meaning but ignorant draftsmen result in grotesque failures. It is best to conform to well-established practice in lettering and the closer we approach it as an ideal, the more successful will be our work.

A very common fault of the beginner is that he does not follow the form and shape of the letters with sufficient care. He does not yet realize the necessity for so doing and is not as yet able to appreciate the difference between good and poor lettering. Fig. 45 shows the first attempt of a student to letter, together with a later attempt after he has learned more about the requirements.

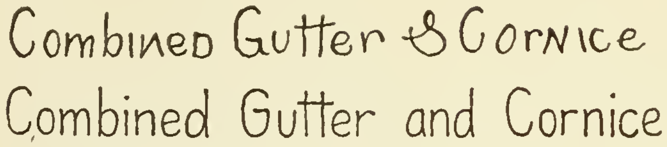


Fig. 45.—Student's First Attempt at Lettering.

38. Engineering Lettering. The style of lettering commonly used by the engineer and frequently used by the architect is called *Gothic* lettering, and is illustrated in Fig. 46.

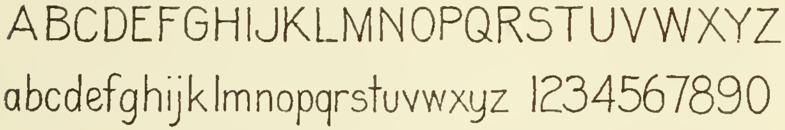

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 1234567890

Fig. 46.—A Gothic Alphabet, Vertical.

This, as you can readily see, is lettering reduced to its lowest terms. The Gothic style is entirely devoid of flourishes or attempts toward embellishment. In fact it is so simple that the least deviation from form is very noticeable.

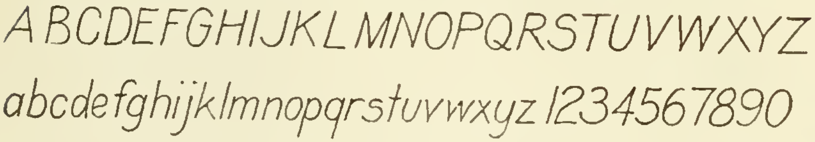

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 1234567890

Fig. 47.—A Gothic Alphabet, Slanting.

You will notice that there are two kinds of letters, *upper case* or capital letters and *lower case* or small letters.

The letters may be made with the stems vertical as shown in Fig. 46, or slanting as shown in Fig. 47. Many prefer the slanting letter as it seems easier to make, especially for the beginner. The angle of inclination should be between 60° and 70°.

39. Architectural Lettering. It was pointed out in the preceding section that the Gothic letter was more or less difficult to render because of its extreme simplicity. If a little more freedom were permissible, slight deviations from the exact form would not be so noticeable. For this reason the architect's draftsman prefers to use a modification of the *Roman* lettering. The pure Roman letter is a shaded letter as illustrated in Fig. 48. For ordinary working drawings shaded letters are unnecessary, especially since they require so much more time in rendering. For this reason a modified single stroke Roman is used, as shown in Figs. 49 and 50. In the styles of architectural letters here illustrated, much more freedom of execution is permissible than when using the classic Roman alphabet.

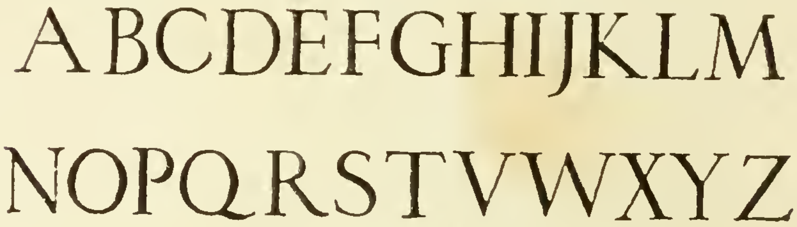


Fig. 48.—A Roman Alphabet.

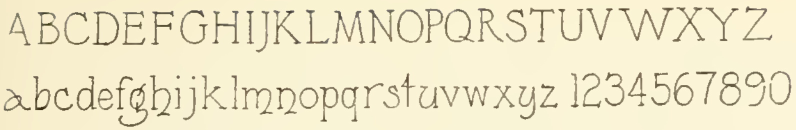

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 1234567890

Fig. 49.—Vertical Single Stroke Roman.

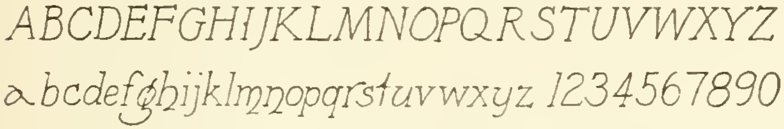

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz 1234567890

Fig. 50.—Slanting Single Stroke Roman.

40. Lettering Practice. The correct posture for lettering is illustrated in Fig. 51. A comfortable position should be assumed with the eyes at a distance of from 12″ to 18″ from the paper. If it is the intention to make slanting letters, the pencil point should be held to the right of the median line of the body. If, however, vertical lettering is desired, the pencil point should be held nearly on the median line of the body.

The pencil should be held lightly but firmly between the thumb and first finger. The muscular movement is not similar to that used in writing, but it is a combined arm and finger movement. Try especially not to cramp the hand or arm when lettering.

There is a tendency for the paper to " spring up " under the pen or pencil. This is particularly troublesome when inking. To overcome this difficulty the fingers of the left hand may be pressed lightly against the paper near the pencil point, as illustrated in the " close-up view " shown in Fig. 52. This figure also shows clearly the proper way to hold the pen in lettering.

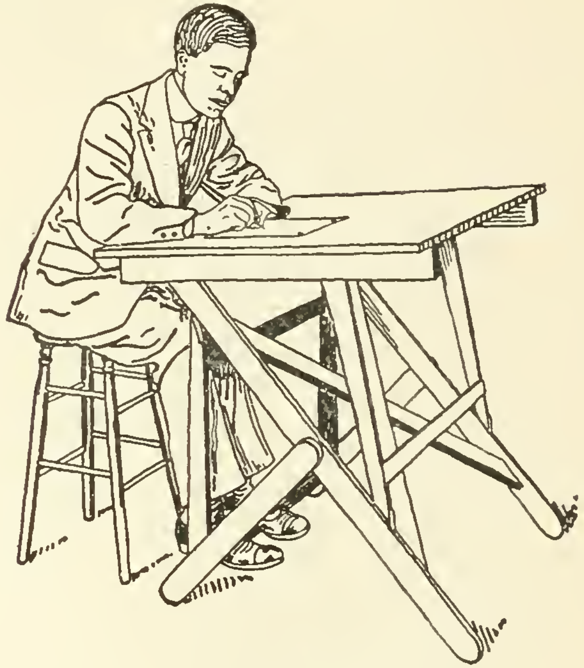


Fig. 51.—The Correct Posture for Lettering.

The sheet should be ruled lightly in guide lines with a pencil. Be sure not to cut into the paper with the pencil as these lines are to be erased later. It is well to allow a space of at least $\frac{1}{4}$″ between the lettering and the border line all around the edge of the sheet. The spacing for the proper height of the letters is suggested in Fig. 53. It is best to begin by drawing a series of vertical, slanting and horizontal lines and to follow this with practice in making the oval as shown in Fig. 54. After this preliminary work has been mastered, the student may practice the formation of the letters of the alphabet. Special care should be taken to follow the exact form of the letters.

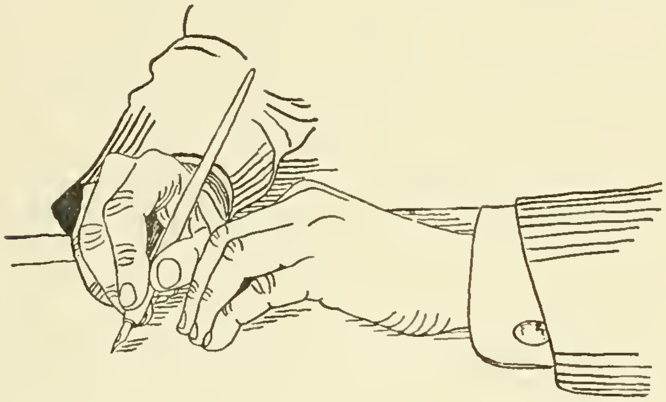


Fig. 52.—The Method of Holding the Lettering Pen.

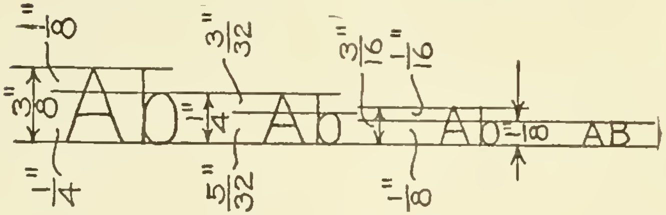


Fig. 53.—Spacing for Letters.

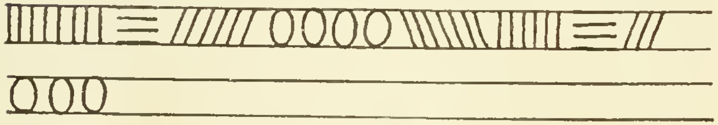


Fig. 54.—Practice Strokes.

41. Inking the Letters. In inking the letters use a Gillott's 303 or 404 pen in an ordinary penholder with a firm round grip. For very heavy lettering use a ball-point pen. Use the quill in the stopper of the ink bottle to charge the pen with ink: do not dip the pen in the bottle. Do not charge the pen too heavily with ink or it will not carry properly. Fig. 55 shows the results when the pen is too heavily charged. Try to keep a uniform pressure on the pen point. Set the point on the paper in the required position. Supply moderate pressure sufficient for the desired width of line and move the pen in the desired direction; cease the movement, remove the pressure and lift the pen.

TOO MUCH INK

Fig. 55.—Pen too Heavily Charged with Ink.

42. Some Rules for Lettering. The following rules for lettering should be observed carefully:

(*a*) Rule off the guide lines accurately and follow them.

(*b*) Observe the forms of the letters closely.

(*c*) Make the lines of the letters of uniform weight.

(*d*) Keep the stems of the letters either uniformly vertical or on a uniform slant.

(*e*) Place the letters of a word close together; approximately $\frac{1}{32}''$ would not be too close for ordinary work.

(*f*) Allow ample space between words; $\frac{1}{8}''$ or $\frac{3}{16}''$ would be about right.

(*g*) Do not try to hurry the work at first. The beginner should put the emphasis on accuracy and let speed come later.

43. Composition of Lettering. An example of careful composition in the architectural style is shown in Fig. 56. Do not attempt to embellish your lettering unless you study the effect thoroughly. The keynote of the work should be simplicity. Gross and elaborate embellishment should be avoided.

The lettering of titles should be arranged symmetrically. Figs. 57 and 58 show two types of titles for drawings executed in the architectural style of free-hand lettering.

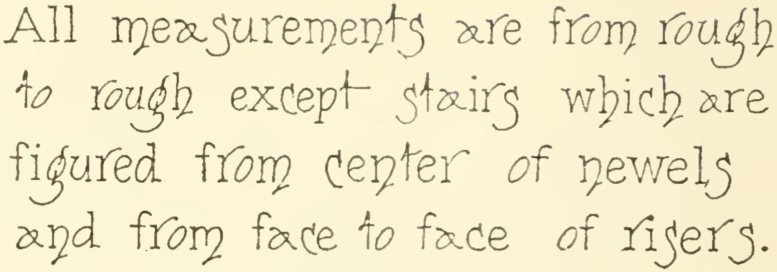

All measurements are from rough
to rough except stairs which are
figured from center of newels
and from face to face of risers.

FIG. 56.—Example of Composition.

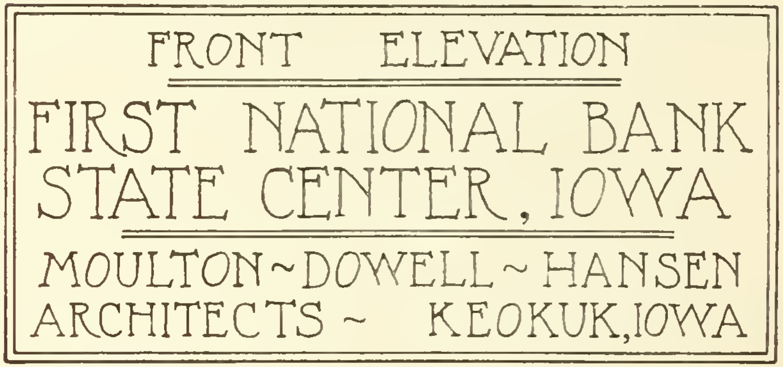
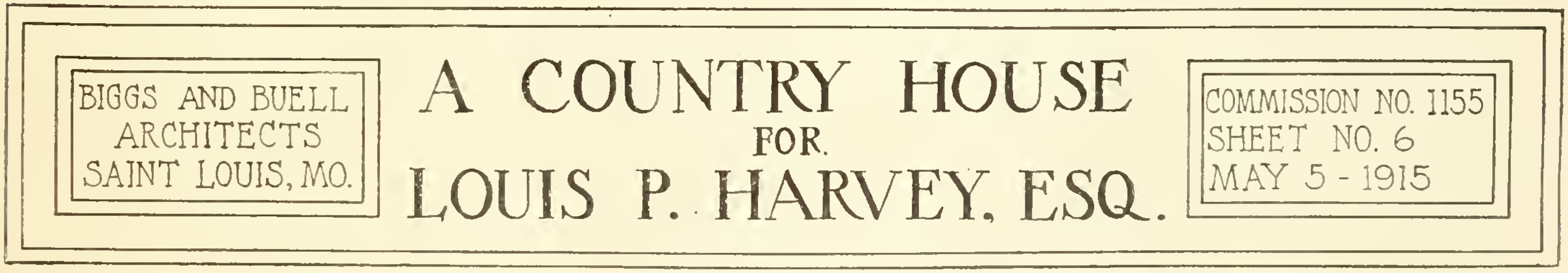

FRONT ELEVATION
FIRST NATIONAL BANK
STATE CENTER, IOWA
MOULTON ~ DOWELL ~ HANSEN
ARCHITECTS ~ KEOKUK, IOWA

FIG. 57.—A Title.


BIGGS AND BUELL
ARCHITECTS
SAINT LOUIS, MO.

A COUNTRY HOUSE
FOR
LOUIS P. HARVEY. ESQ.

COMMISSION NO. 1155
SHEET NO. 6
MAY 5 - 1915

FIG. 58.—Another Title.

CHAPTER V

STRAIGHT-LINE PROJECTION

44. Straight-Line Projection; What It Is The essential difference between perspective drawing and straight-line projection was pointed out in Chapter I. The student is now familiar, doubtless, with the fact that a perspective drawing gives an image of the object as it appears, and that a straight-line drawing shows the object as it really is; in its true size and shape. He is also aware that the invisible portions of the object may be represented by dotted lines. In this manner the information required for the complete definition of the object may be recorded.

In order that this may be done expeditiously and to facilitate the reading of the finished drawing, use is made of certain well-defined conventions. These we will study in the material that follows.

45. Planes of Projection. If we set up a plane between the eye and an object as shown in Fig. 59, and if we draw lines from each point of the object perpendicular to the plane until they intersect it, the result will be an image of the object on the plane. This plane, marked V–V in the figure, is called the *plane of projection,* the perpendicular lines are called the *projecting rays* and the image on the plane is called the *view,* or the projection. If the object is placed with the plane of its face parallel to the plane of projection, the image will appear in the true shape and size of that face of the object, but the lines of the object which are perpendicular to the plane of projection will be projected only as points. Thus it will be seen that one view is generally not sufficient to completely define the object.

46. Relation of the Views. Not only are two or more views necessary to completely define an object of three dimensions, but it is necessary also that the relation of the views to each other be clearly understood. In Fig. 60 the same object that was shown in Fig. 59 is represented, but in addition to the vertical plane shown in the previous figure, a horizontal plane, marked H–H, and an end view plane marked P–P, are shown. These three planes, the *vertical,* the *horizontal,* and the *profile* planes, are mutually perpendicular to each other, thus forming the sides of a transparent box, as it were. Rays are drawn from the object to each of these planes, forming a *front view* or *front* *elevation* on the vertical plane, a *top view* on the horizontal plane and an *end view* or *end elevation* on the profile plane. Now if the horizontal plane be swung around on the line of its intersection with the vertical plane in the direction indicated by the arrow in Fig. 60, and if the profile plane be swung about its intersection with the vertical plane in the same manner until they both coincide with the vertical plane extended, the three views may be thought of as lying in one plane and may thus be represented on the plane of the paper. The relation of these three views to each other is essential in understanding the actual shape and size of the original object, and this relation must not be lost sight of in making and reading a straight-line drawing. It will be noticed in looking at the straight-line projection of the object shown to the right in Fig. 60, that the top view is

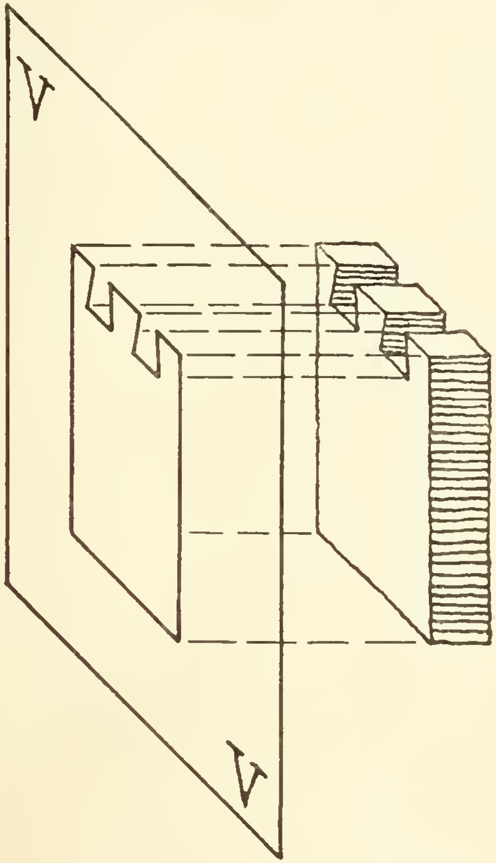


Fig. 59.—The Vertical Plane of Projection.

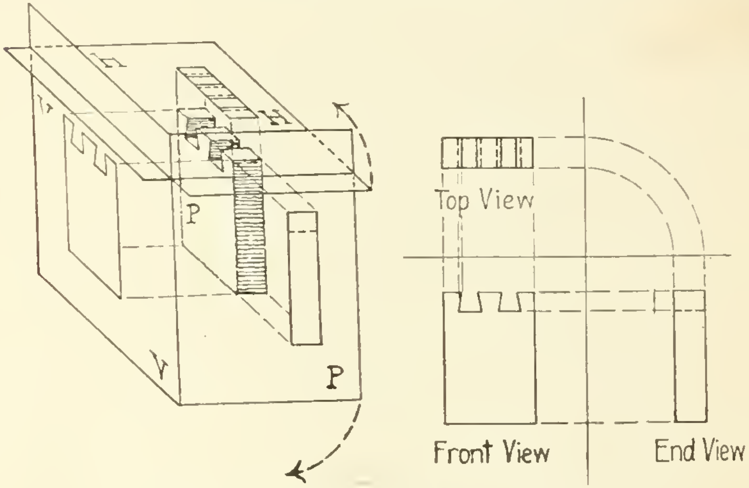


Fig. 60.—The Principal Planes of Projection.

directly above the front elevation, that the right end view is directly to the right of the front elevation and that the left end view is directly to the left of the front elevation. In this figure the right end view only is shown, but a left end view might be shown with equal propriety. In actual practice the intersections of the principal planes of projection are not shown, but the main lines of the drawing and the center lines are used for reference lines as shown in Fig. 61. It frequently happens that only two views are really necessary to completely define an object, and in that case the third view is omitted. The beginner will do well to use the lines which indicate the intersections of the planes until he has thoroughly mastered the fundamental principles of straight-line projection.

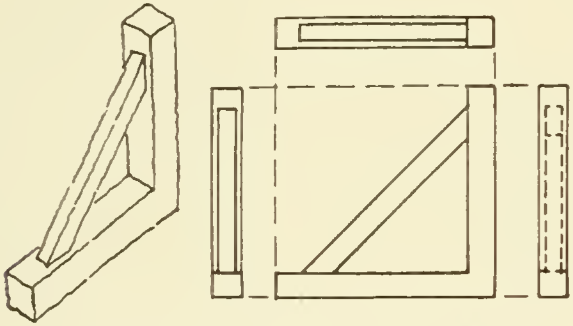


FIG. 61.—A Straight-line Projection Drawing.

In reading a drawing each view should be carefully studied in relation to the other views. One cannot expect to read a drawing at a single glance, as considerable study is necessary before the complete meaning can be grasped, especially in the case of complicated drawings.

47. Auxiliary Views. It is sometimes desirable to show an *auxiliary view* of a portion of an object, and especially is this true if the plane of this portion is not parallel to one of the three principal planes of projection. It is also frequently of advantage to show a detail view to a much larger scale than that of the general view. In this case an auxiliary plane of projection is used, and this plane is placed in the most convenient position for the purpose. Fig. 62

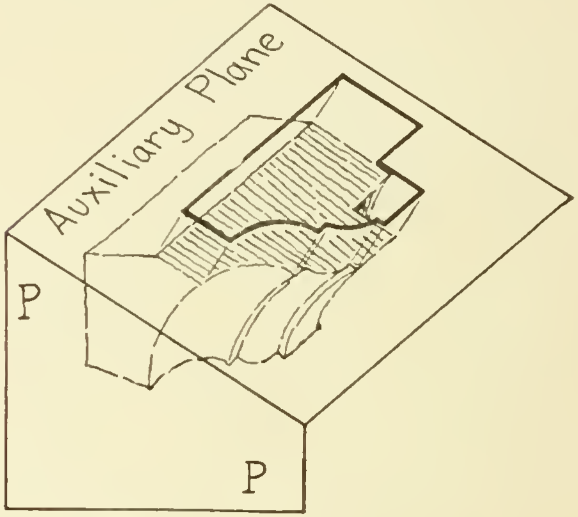


FIG. 62.—An Auxiliary Plane of Projection.

shows the application of such an auxiliary plane and Fig. 63 shows the resulting straight-line projection.

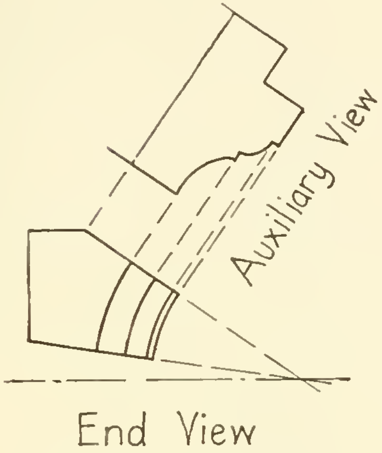


Fig. 63.—An Auxiliary View.

48. Sectional Views. To show the interior of an object with especial clearness, it is often desirable to make a *sectional view*. An imaginary plane is passed through the object and this plane is used as an auxiliary plane of projection. The resulting view is called a sectional view. The object is drawn as it would appear if cut through by a saw and a portion removed so that the interior will stand out clearly. That surface through which the imaginary saw passes is indicated by *section-lining* or *cross-hatching.* In removing a portion of one view in this manner, the other views of the same object are not changed, but they are shown in full. However, in the accompanying views the edge of the cutting plane is often indicated by a line. This helps to define the limits of the sectional view.

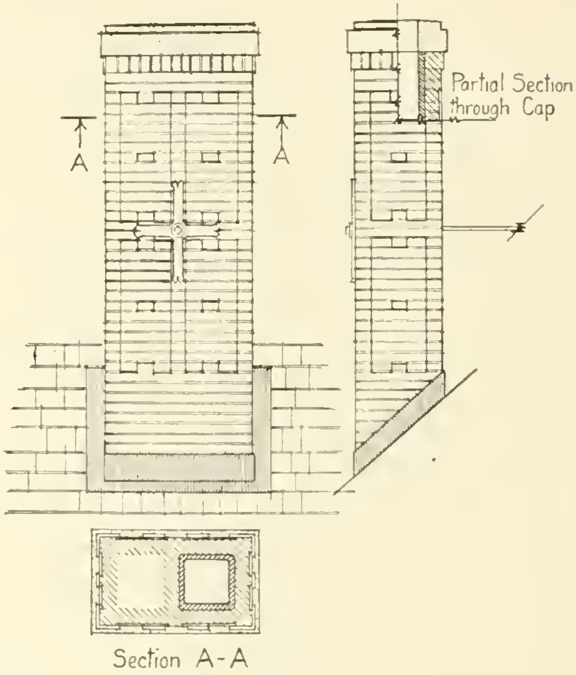


Fig. 64.—A Sectional View.

A sectional view is shown in Fig. 64, and the location of the imaginary cutting plane is indicated by a line marked A–A.

If an object is the same on both sides of a central axis, one half is often shown in section and the other half in full lines. Such a view is called a *half-sectional view*.

In cross-hatching a sectional view various arrangements of lines may be used to indicate various materials. In this event a *legend* should be appended in a convenient position on the sheet to indicate the meaning of the various sets of lines. This point is illustrated in Fig. 65.

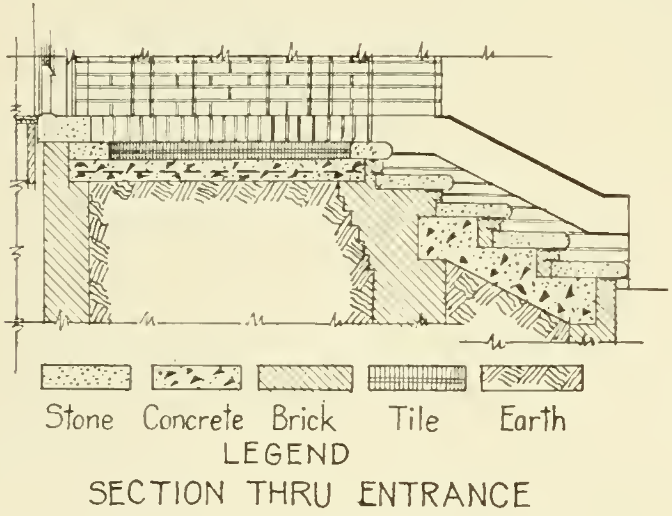


Fig. 65.—A Sectional View with a Legend.

A small revolved section may often be used with convenience to indicate the shape of a piece in a direction at right angles to the plane of the paper. This is frequently done in connection with drawings for steel work as shown in Fig. 66.

49. Revolution of Views. In practical drafting the object should be so placed with reference to the planes of projection that the resulting view will be the simplest and the easiest to make. This occurs when the face plane of the object is parallel to the plane of projection. It is sometimes convenient, however, to represent an object in a position which is oblique to the planes of projection. The best way to attack such a problem is first to draw the object in a position parallel to the planes of projection and then to

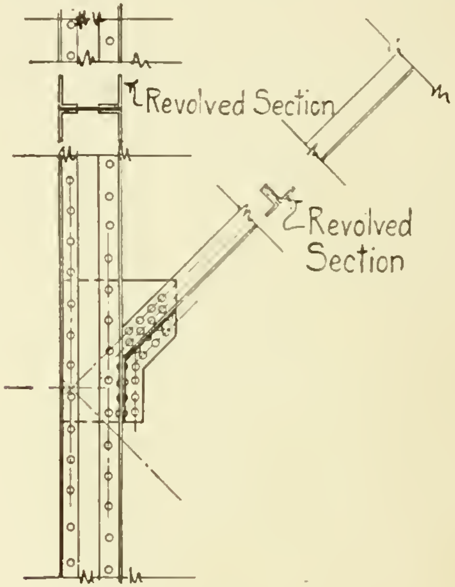


Fig. 66.—Revolved Sections.

revolve the successive views about axes perpendicular to the planes until the desired position is obtained. The view of an object may be revolved about an axis perpendicular to the plane of its projection without changing the shape or size of its projection on that plane. This is the *principle of revolution.*

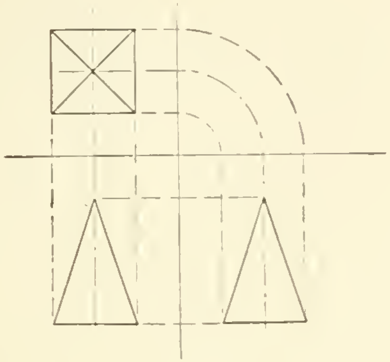


Fig. 67.—A Square Pyramid in Simple Projection.

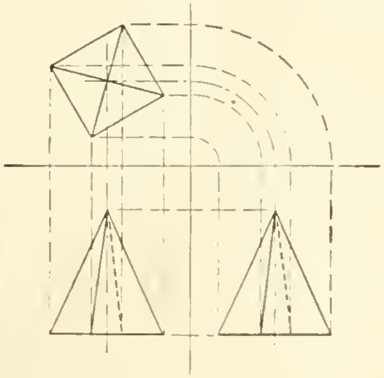


Fig. 68.—A Square Pyramid in Revolved Position.

As an example of what may be done let us take the square pyramid shown in Fig. 67. In this figure the object is taken with the plane of its base parallel to the horizontal plane of projection and the edges of its base parallel to the vertical and profile planes. If it is desired to revolve the object so that the edges of the base will make 30° and 60° angles with the vertical and profile planes, the object is thought of as being rotated about its axis, which is perpendicular to the horizontal plane. The shape and size of the horizontal projection will remain unchanged, but its relation to the two other views and the resulting change in these views is shown in Fig. 68. If it is further desired

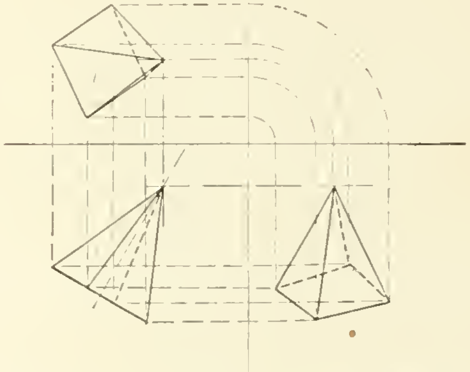


Fig. 69.—A Square Pyramid Oblique to the three Principal Planes.

to rotate the object so that the vertical axis will make an angle of 60° with the horizontal plane, the projection on the vertical plane will remain unchanged in shape and size from that shown in Fig. 68, but the other views will be changed as shown in Fig. 69.

In actual drafting practice objects would seldom if ever be placed in such complicated positions as those illustrated above, but such problems are excellent practice in assisting the student to come to a complete understanding of the principles of straight-line projection.

DRAWING FOR BUILDERS

DIRECTIONS FOR THE PROBLEMS

PROBLEMS: PART I

GEOMETRIC DRAWING AND PROJECTION

TITLES

Problem 1. Practice in Line Drawing.
Problem 2. Practice with Circles and Arcs.
Problem 3. Geometric Constructions.
Problem 4. Geometric Constructions.
Problem 5. Geometric Polygons.
Problem 6. Geometric Construction for Ionic Volute.
Problem 7. Projection of Hollow Cylinder.
Problem 8. Projection of Hexagonal Prism.
Problem 9. Projection of Pentagonal Pyramid.
Problem 10. Dimensioned Cube in Projection.

INTRODUCTION

This text comprises a problem course in drawing for carpenters, woodworkers, builders and architect's draftsmen. It is also suitable for use in the study of elementary architectural drawing in schools.

Part I consists of exercises in line drawing, geometric drawing and projection. These problems are essential for those who would pay particular attention to the technique of drawing and desire a thorough understanding of the principles of straight-line projection.

Part II consists of graded exercises suitable for manual training work in wood. Any one of the familiar articles illustrated may easily be made by the student and he should be encouraged to make them, thus correlating his work in the drawing room and the shop. They are believed to be equally interesting to the carpenter, particularly the beginner.

Parts III and IV consist of details of building construction in wood. They are of special interest to builders, mill-men and architect's draftsmen, though they may be followed with profit by anyone interested in building construction.

Part V consists of details of building construction in stone, brick, tile, terra-cotta and iron.

Each problem is stated in several parts of increasing difficulty. These are not merely set examples to copy, but each requires original work on the part of the student. By this method it is hoped that the student's judgment and initiative will be developed.

For many students, pencil work only is all that is required. For the practical builder this is generally all that is necessary. The draftsman, of course, should have practice in inking and tracing in ink. The ink work may profitably be begun with Part II and the tracing with Part III.

Particular attention should be given to neatness and accuracy. The master-workman will be as quick to condemn a poor drawing as he is to criticise slovenly workmanship in wood. The ability to make a neat, workmanlike drawing comes only with practice. Continual effort should be made to improve the character of the work. When the course is completed this progress should be very apparent.

PROBLEM 1. PRACTICE IN LINE DRAWING

The student should read the accompanying directions carefully before attempting to make any of the drawings.

Inasmuch as the work in this drawing course consists largely of the drawing of lines it seems logical to begin the problem work with practice in line drawing. Much pains should be taken with this preliminary work. You should especially train yourself to be neat and accurate. Be as careful with the pencil work as though it were not to be inked over. When the pencil work is completed, it should look exactly like the ink work will be expected to look. While working on these problems refer constantly to the explanatory material which has preceded the problem section, as many valuable suggestions with which you should be very familiar are there given. Do not fail to read the directions and the statement which accompanies every problem before starting on the drawing. By so doing you will save yourself much trouble.

Use the standard $8\frac{1}{2}'' \times 11''$ sheet for all of the following problems. This is a convenient size and the work has been arranged for this size sheet. See Chapter III for the arrangement of this standard sheet.

a. Lay out a standard sheet and divide it into six equal squares $2\frac{5}{8}'' \times 2\frac{5}{8}''$ as shown in the accompanying drawing. This will allow a space of $\frac{1}{2}''$ between each square and the border line and between the squares. Do not put on your drawing the dimensions shown, as these are merely given for your information and convenience.

In square No. 1 draw a series of horizontal lines $\frac{1}{8}''$ apart and the full length of the square. Be sure that your lines are carefully and evenly spaced.

In square No. 2 draw a series of vertical lines $\frac{1}{8}''$ apart.

In square No. 3 draw both horizontal and vertical lines $\frac{1}{8}''$ apart. This will make a checkerboard pattern.

In square No. 4 draw a series of diagonal lines slanting downward to the left $\frac{1}{8}''$ apart. For this it will be convenient to use the 45° triangle.

In square No. 5 draw a series of diagonal lines slanting downward to the right $\frac{1}{8}''$ apart.

In square No. 6 draw diagonal lines $\frac{1}{8}''$ apart slanting in both directions and making a diagonal checkerboard pattern.

In the lower right-hand corner of your drawing fill out the block by lettering very carefully_the name of your school and the other necessary information.

When the pencil work is completed submit it to your instructor for approval. After the pencil work has been approved, proceed with the inking if directed to do so.

b. Lay out a standard sheet and divide it into squares as previously directed.

Divide square No. 1 into two equal parts by a vertical line through the center. Fill the space to the left with horizontal lines ⅛″ apart and the space to the right with vertical lines ⅛″ apart.

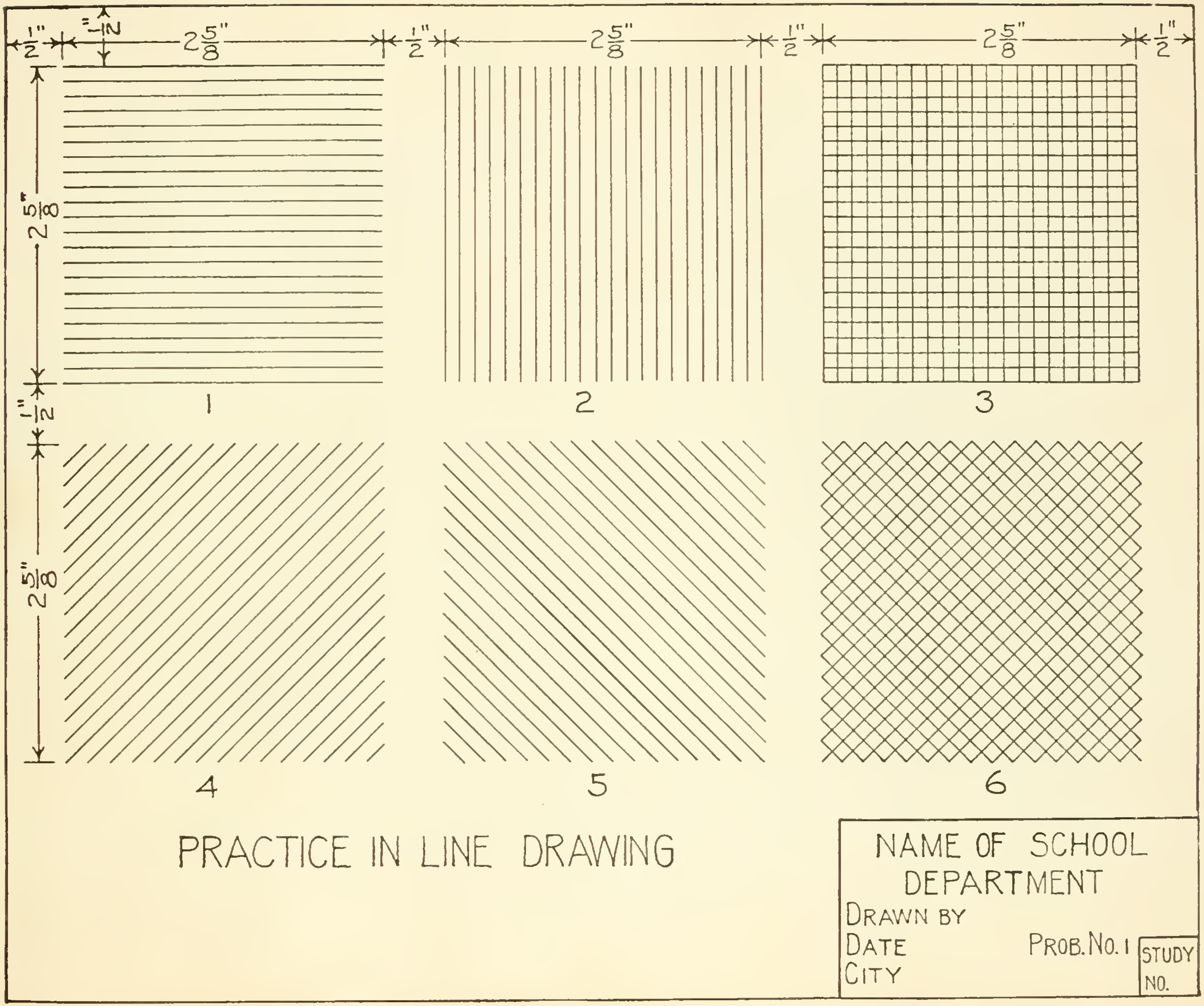
Divide square No. 2 into two equal parts by a diagonal line from the upper left-hand corner to the lower right-hand corner. Fill the space to the left of this line with horizontal lines ⅛″ apart and the space to the right with vertical lines ⅛″ apart. Make sure that the horizontal and vertical lines join precisely on the diagonal line.

In square No. 3 draw a series of parallel squares ⅛″ apart and diminishing in size with the smallest one at the center.

In square No. 4 find the center of each side and join these points with diagonal lines. In the square thus formed draw a series of squares ⅛″ apart and diminishing in size toward the center.

In square No. 5 divide the upper and right-hand edge into points ⅛″ apart. Join each of these points to the lower left-hand corner of the square, thus forming a fan-shaped figure. With the point of convergence of these lines as a center and with a radius of ½″ draw an arc lightly in pencil. The converging lines should terminate in this arc, but if the drawing is to be inked do not ink the arc itself.

Find the center of the upper side in square No. 6 and join this point to each of the lower corners forming a triangle. Draw a series of diminishing triangles ⅛″ apart with the smallest triangle in the center. Fill the remaining space to the right and left with lines ⅛″ apart and parallel with the sides of the triangles.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6
PRACTICE IN LINE DRAWING
NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 1
STUDY NO.

PROBLEM 2. PRACTICE WITH CIRCLES AND ARCS

This drawing is intended to give you practice in the use of the compass. Be sure to read over the previously given directions for the use of the compass very carefully before starting this drawing.

a. Lay out a standard $8\frac{1}{2}'' \times 11''$ sheet as previously directed. Divide this sheet into six equal squares. Copy the work shown in the accompanying drawing.

In square No. 2 the radius of the arcs at the corners is $\frac{1}{2}''$. The interval between the parallel lines is $\frac{1}{8}''$. The three inner circles are concentric.

If you study the accompanying drawing carefully you will have little trouble in completing your drawing satisfactorily.

b. Lay out a standard sheet and divide it into squares as previously directed.

In square No. 1 inscribe the largest possible circle and draw a series of concentric circles $\frac{1}{8}''$ apart and diminishing in size toward the center. Erase the circumscribed square so that only the circles show.

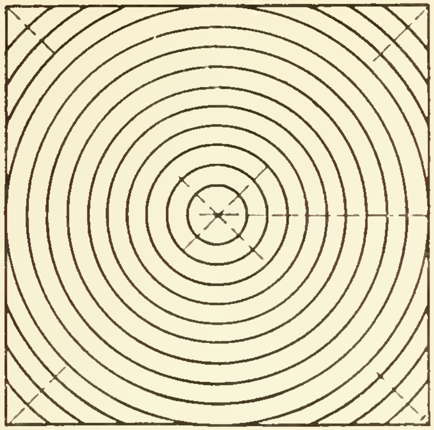
In square No. 2 with each corner taken successively as a center draw a series of arcs terminating in the edge of the square.The largest radius used should be equal to one-half the length of the side of the square.

In square No. 3 use the lower left-hand corner as a center and scribe an arc the radius of which is equal to the side of the square. Divide this arc into equal spaces about $\frac{1}{4}''$ apart and through each of these points draw a horizontal line. When inking this square, do not ink the circular arc but erase the pencil line.

Lay out square No. 4 similar to No. 4 in the accompanying drawing. Draw a series of concentric circles $\frac{1}{8}''$ apart in each of the circles there shown.

Divide square No. 5 into horizontal and vertical lines $\frac{3}{8}''$ apart. Using the center of each small square thus formed as a center inscribe a number of circles having $\frac{3}{16}''$ radius

Draw any similar arrangement of circles or circular arcs in square No. 6.



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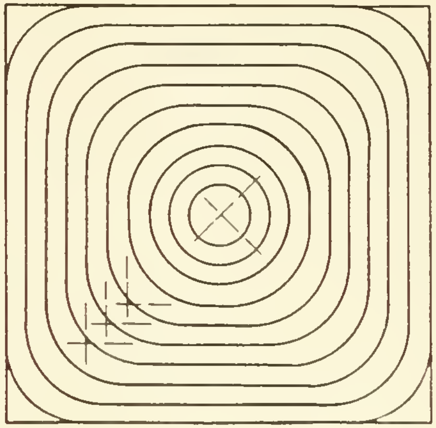

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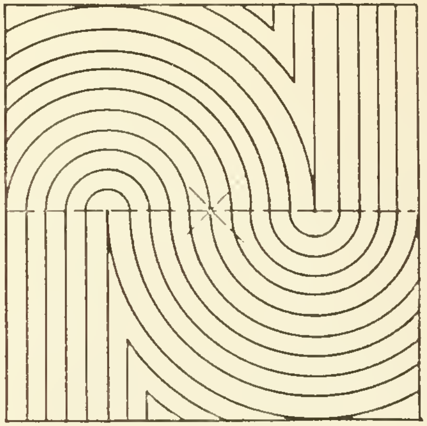

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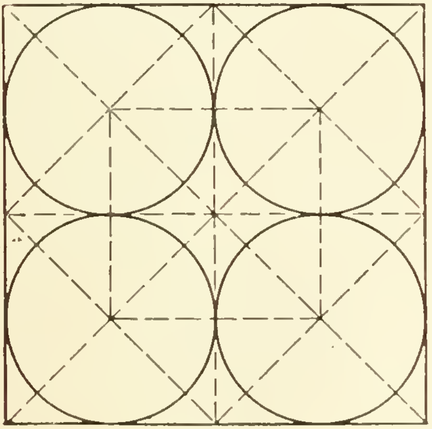

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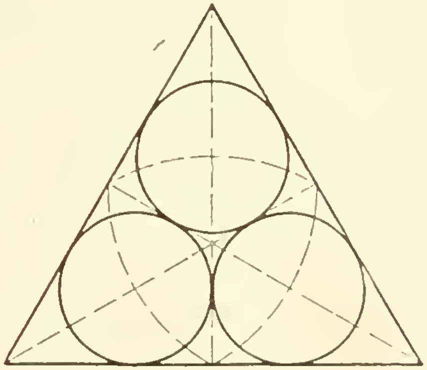

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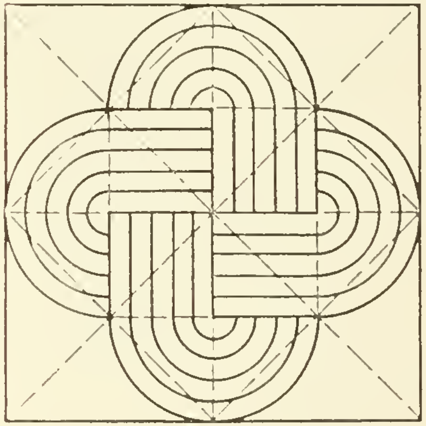


6

PRACTICE WITH CIRCLES AND ARCS

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE PROB. NO. 2
CITY
STUDY
NO.

PROBLEM 3. GEOMETRIC CONSTRUCTIONS

Geometric constructions are frequently used by the draftsman, although in many cases the practical method is the more rapid. For example, if the draftsman wishes to erect a perpendicular to a given line, he merely draws the perpendicular by means of his triangle or set square, the edges of which have been already made perpendicular. On the other hand, there are many geometric constructions which are valuable to the draftsman because he can make practical use of them.

a. Lay out a standard sheet and divide it into six squares as previously directed.

To Erect a Line Perpendicular to a Given Line at its Extremity. In a convenient position in the lower portion of No. 1 assume the given line AB. With any convenient point C as a center and the distance from A to C as a radius scribe the arc BAD. At the point B where this arc intersects the line AB draw a line through C to cut the arc in D. Join A and D. The line AD is the required perpendicular.

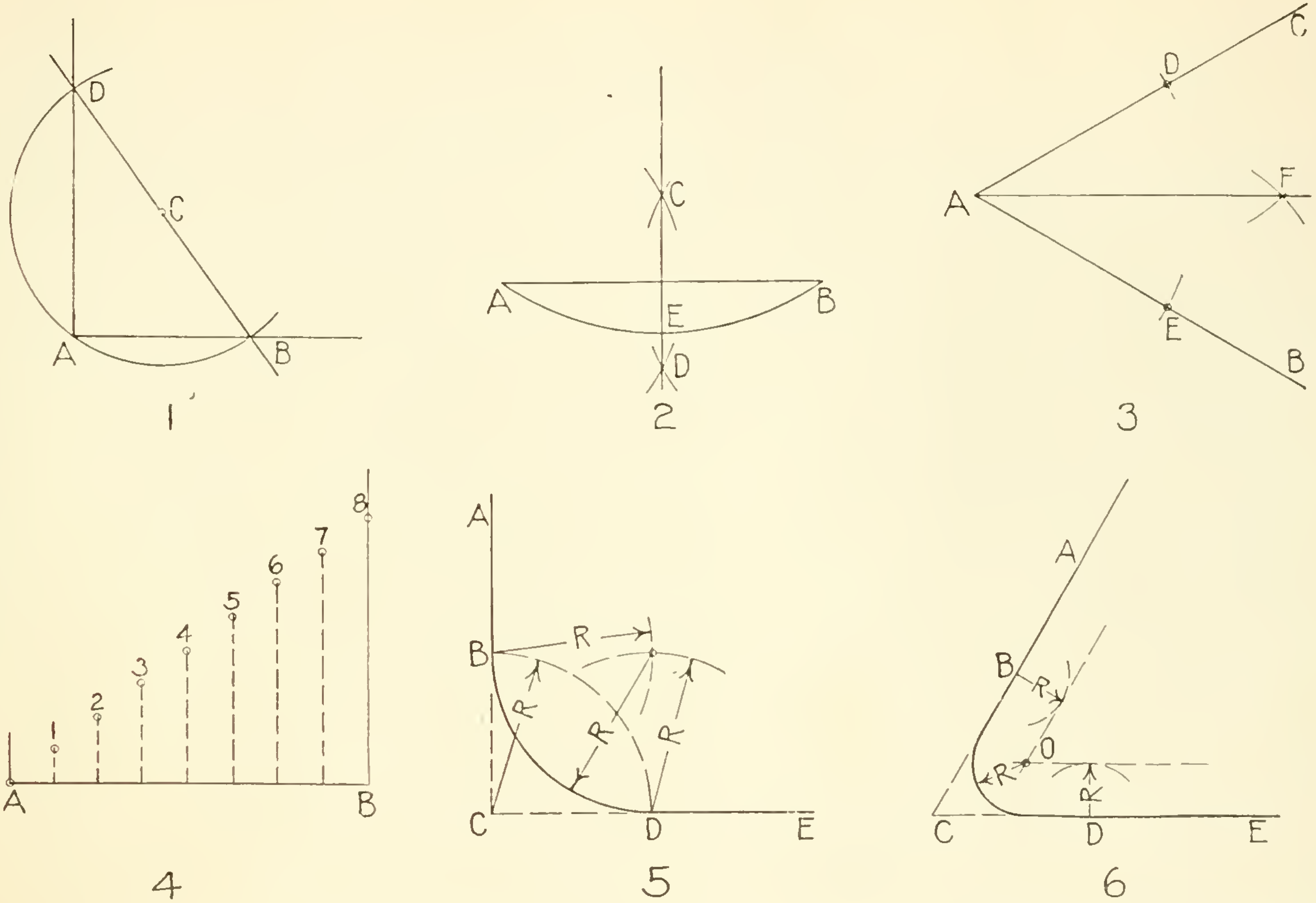
To Bisect a Line and to Erect a Perpendicular at its Middle Point or to Bisect a Given Arc. Let AB in No. 2 be the given line and AEB the given arc. With A as a center and a radius greater than half the distance between A and B draw an arc above and one below the given line. With B as a center and the same radius draw arcs above and below the line to intersect the arcs previously drawn at C and D. Join C and D. CD cuts the given line AB and the given arc AEB at their middle point. CD is also perpendicular to AB.

To Bisect an Angle. Let BAC in No. 3 be the given angle. With A as a center and any convenient radius draw arcs to intersect AC in D and AB in E. With D as a center and any convenient radius draw an arc toward the center of the angle. With E as a center and the same radius draw an arc to intersect the first in the point F. Join F and A. AF is the required bisector.

To Divide a Line into any Given Number of Equal Parts. Let the line AB in No. 4 be the given line. Let it be required to divide the line into eight equal parts. At either extremity, B for example, erect a perpendicular to the line. Using a scale, or any convenient method of measurement, lay it diagonally with the zero mark at A and the eighth division on the perpendicular through B. Prick the paper at each division on the scale and from these points 1, 2, 3, . . . draw lines perpendicular to AB. These perpendiculars will divide AB into eight equal spaces.

To Draw an Arc Tangent to Two Given Lines which Meet at Right Angles. Let AC and CE be the two given lines in No. 5. Let R be the radius of the required arc. With C as a center and the radius R strike an arc to intersect AC in B and CE in D. With B as a center and R as a radius draw an arc and with D as a center draw a similar arc. With the intersection of these two arcs as a center and the radius R draw the required arc, which will be tangent to AC at B and to CE at D.

To Draw an Arc Tangent to Two Given Lines which Meet at any Angle. Let AC and CE be the given lines in No. 6. Let R be the radius of the required arc. With B, any convenient point on AC as a center and R as a radius, strike an arc. Tangent to this arc draw a line parallel to AC. With D, any convenient point on CE as a center and R as a radius strike a similar arc and draw a line tangent to the arc and parallel to CE. The two parallel lines will intersect in O. With O as a center and radius R draw the required arc.



GEOMETRIC CONSTRUCTIONS

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. No.3
STUDY
NO.

PROBLEM 4. GEOMETRIC CONSTRUCTIONS

This problem is a continuation of the work given in Problem 3.

a. Lay out a standard sheet as previously directed.

To Find the Center of a Given Circular Arc. Let ABC in No. 1 be the given arc. Draw two intersecting chords, such as AB and BC. Draw the perpendicular bisectors of each of these chords, DE and FG. These will intersect in the point O, which is the required center.

To Pass a Circle Through any Three Given Points. Let the three points be A, B, and C in No. 2. Join the points with straight lines. Find the perpendicular bisectors of two of these lines, as AC and BC. These are the lines FG and DE. These lines intersect in the point O. With O as a center and OA as a radius, draw the required circle.

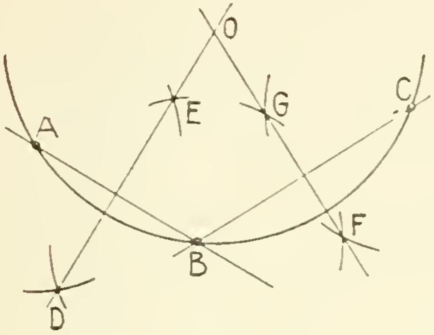
To Construct a Reverse Curve. The reverse curve or O-G curve is frequently used in mouldings and the practical builder should know how to construct it.

Draw the diagonal AB of the square in which the curve is to be described as shown in No. 3. Find the center of the square E. With D as a center and a radius equal to DE scribe the arc BE. With C as a center and the same radius scribe the arc EA to complete the curve.

To Construct an Approximate Ellipse with Circular Arcs. The ellipse is a curve which is frequently used in building construction. It is a sort of elongated circle. The longer diameter is called the major axis and the shorter diameter is called the minor axis. In No. 4 lay off AB for the major axis and CD for the minor axis. Join C and B. Lay off OE on OB equal to OC and from C on CB lay off CF equal to EB. Bisect the distance between F and B and erect the perpendicular bisector. This intersects the major axis AB at H and the minor axis CD at G. With G as a center and a radius equal to GC scribe an arc. With the corresponding point G′ as a center and the same radius scribe another arc. With H as a center and HB as a radius scribe a third arc to meet the two previously drawn. With the corresponding point H′ as a center and the same radius scribe the fourth arc to complete the ellipse.

To Construct an Ellipse by the Trammel Method. Start with the major and minor axes, as shown in No. 5. On the edge of a small strip of paper lay off the distance a–c equal to OB, one-half of the major axis. Also lay off from c the distance b–c equal to one-half the minor axis, OC. With the point a, constantly on the minor axis and the point b, constantly on the major axis revolve the strip and mark consecutive positions of the point c. Join these with a smooth curve to form the ellipse.

To Construct the Spiral of Archimedes. Lay out a circle of any convenient size and divide it into twelve equal parts by radial lines through the center. Starting at the center of the circle O lay off twelve or more equal distances of convenient length. The longer these distances are the more rapid will be the *divergence* of the spiral. One-eighth of an inch is a convenient spacing to use in this case. At the first point draw an arc free-hand which stops at the first radial line. At the second point draw an arc which stops at the second radial line, and so on. Join the ends of these arcs with a smooth curve to form the spiral.



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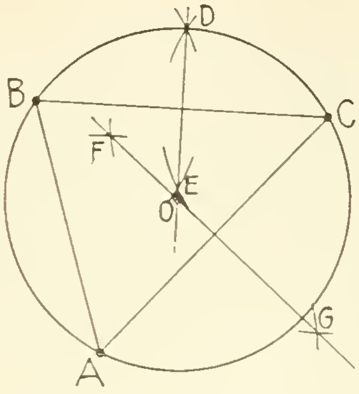

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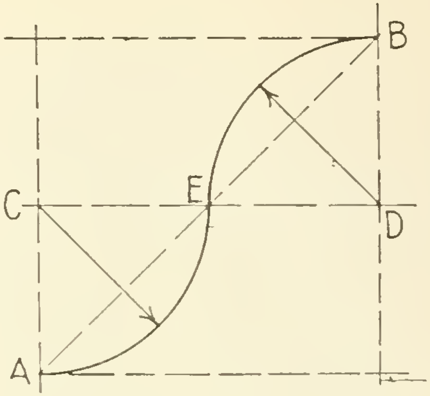

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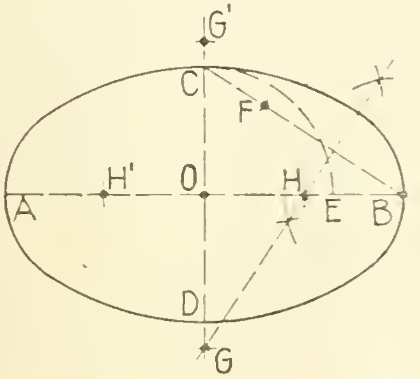

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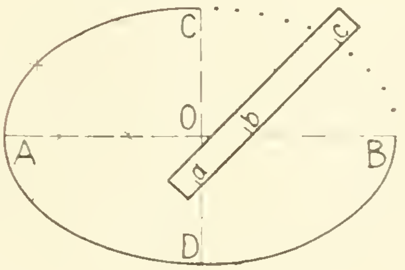

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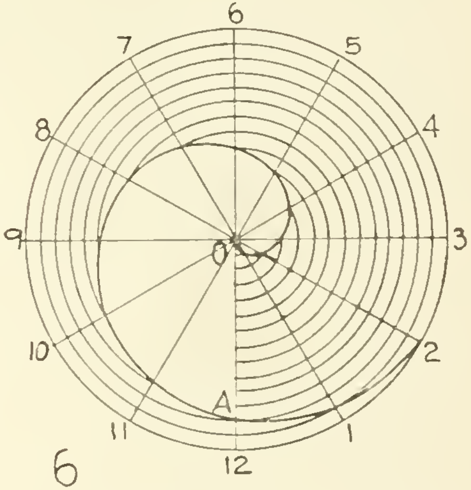


6

GEOMETRIC CONSTRUCTIONS

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 4
STUDY NO.

PROBLEM 5. GEOMETRIC POLYGONS

One valuable use for geometric constructions is in drawing regular polygons. Such polygons are used in building operations for tiles, mosaics, windows and sections of posts and piers.

To Construct an Equilateral Triangle. Lay off the lower side AB. With A as a center and a radius AB, scribe an arc. With B as a center and the same radius, scribe an arc to intersect the first arc at C. Join AC and BC to form the triangle.

To Construct a Square. Lay off the lower side AB. With B as a center and any convenient radius R, scribe an arc. Measure off the radius on this arc from a to b and from b to c. With b as a center and any convenient radius scribe an arc. With c as a center and the same radius scribe a second arc to intersect the first at d. Draw BC through d. With B as a center and BA as a radius scribe an arc to limit BC at C which is one corner of the square. With A as a center and AB as a radius scribe an arc. With C as a center and the same radius scribe a second arc to intersect the first at D and B. Join CD and DA to complete the square.

To Construct a Pentagon. A regular pentagon is a five-sided figure having all its sides of equal length.

Scribe a circle with diameter of convenient length as AB. Draw diameter CD at right angles to AB through the center O. Find the center distance between O and B at a. With a as a center and aD as a radius, scribe an arc to intersect AB at b. With D as a center and the distance from D to b as a radius draw an arc to intersect the circle at E. This radius, R_2, is one-fifth of the circle and may be stepped off to find the points F, G and H. Join D, E, F, G, H and D to complete the pentagon.

To Construct a Regular Hexagon. A regular hexagon is a six-sided figure having sides of equal length.

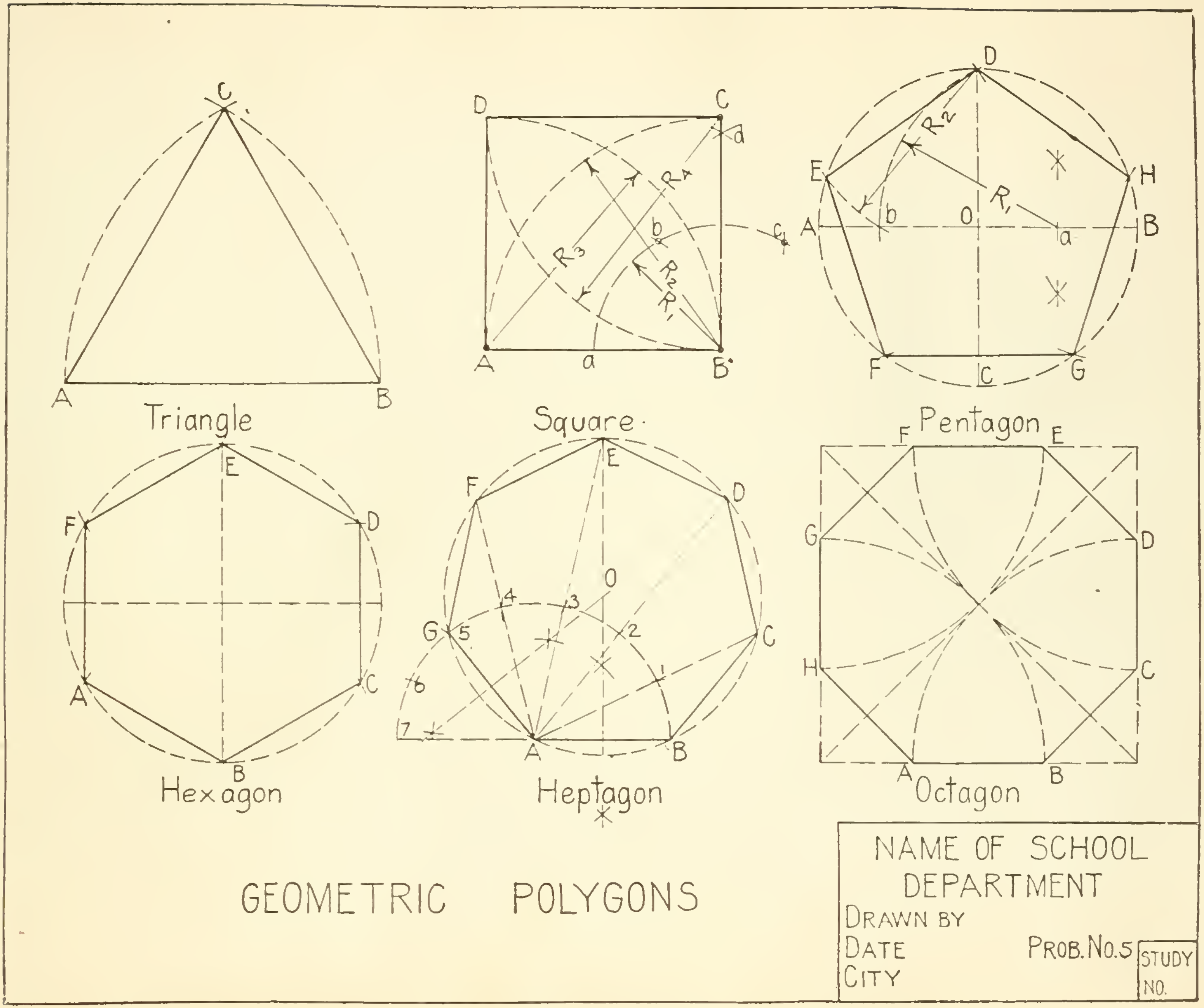
Draw a circle having a convenient diameter. Starting at any point B step off the radius of the circle to locate the points A, C, D, E and F. Join these points to form the hexagon.

To Construct a Regular Heptagon. A regular heptagon is a seven-sided figure having its sides all equal.

Start with the lower side AB of convenient length. Make AB about $1\frac{1}{8}''$ for convenience in this case. With A as a center and AB as a radius draw a semicircle. Divide this into seven equal parts. Join A and 5 to get AG, one side of the figure. Find the perpendicular bisectors of AB and AG. These intersect at O, the center of the circumscribed circle. With O as a center and OA as a radius draw a circle. Extend A–1 to intersect the circle at C, A–2 to intersect it at D, A–3 at E and A–4 at F. Join B, C, D, E, F and G to form the heptagon.

To Construct a Regular Octagon. A regular octagon is an eight-sided figure having equal sides.

Construct the square in which the octagon is to be drawn. With each of the four corners used successively as centers and with one-half of the diagonal of the square as a radius, scribe arcs to intersect the sides of the square in the points A, B, C, D, . . . etc. Join these points to form an octagon.


C
A
B
Triangle
D
C
d
R_4
R_3
b
R_2
R_1
c
A
a
B
Square
D
R_2
E
H
R_1
A
b
O
B
a
F
C
G
Pentagon
E
F
D
A
C
B
Hexagon
E
F
D
O
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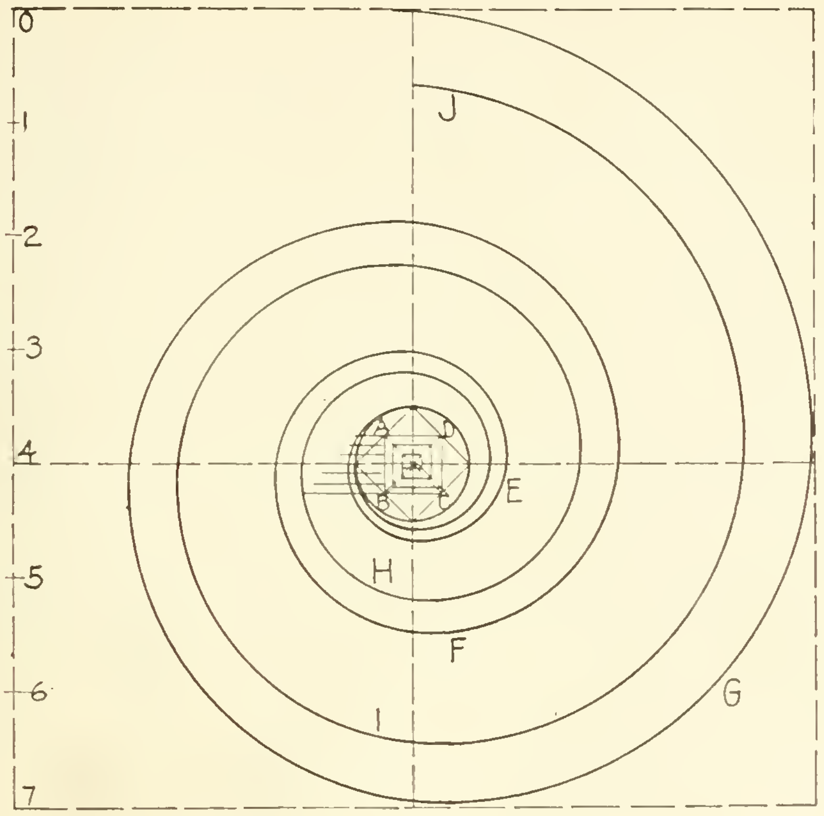
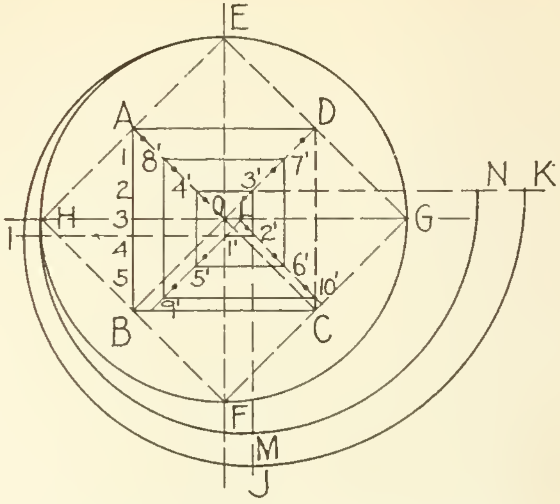
3
G
5
2
C
1
6
7
A
B
Heptagon
F
E
G
D
H
C
A
B
Octagon
GEOMETRIC POLYGONS
NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 5
STUDY NO.

PROBLEM 6. TO CONSTRUCT THE IONIC VOLUTE.

The Ionic volute is the curve at the corners of the Ionic capital. It consists of two diverging spirals joined near the center and tangent to a small circle or eye.

Lay out a square of convenient size in which the curve is to be drawn. A square 5″ on a side would be about right in this case. Divide the left-hand side of this square into seven equal parts. Draw a horizontal line on division 4. At the center of this line draw a circle whose radius is equal to one-half of one of the divisions to the left. In this small circle draw a diagonal square and in this draw the square ABCD. Divide AB into six parts, as shown in the enlarged view to the right. Half way between 3 and 4 draw the line 1′–2′, half way between 4 and 5 draw 5′–6′ and half way between 5 and B draw 9′–10′. Even with 2 draw 3′–4′ and even with 1 draw 7′–8′ each to intercept the diagonals AO and DO. Join 2′–3′, 4′–5′, 6′–7′ and 8′–9′. With 1′ as a center and 1′E as a radius, draw the arc EI. With 2′ as a center and 2′I as a radius,. draw the arc IJ. With 3′ as a center and 3′J as a radius, draw the arc JK. Continue in the same manner to form the spiral EFG shown in the view to the left. To construct the inner spiral draw the line 9′–L and L–10′. Bisect the distance between L and 2′ and with this point as a center and its distance to H as a radius draw the arc HF. Lay off the same distance from 3′ on the diagonal OD and with the distance to M as a radius draw the arc MN. Continue in the same manner to complete the spiral HIJ shown in the view to the left.





Enlarged View of Center

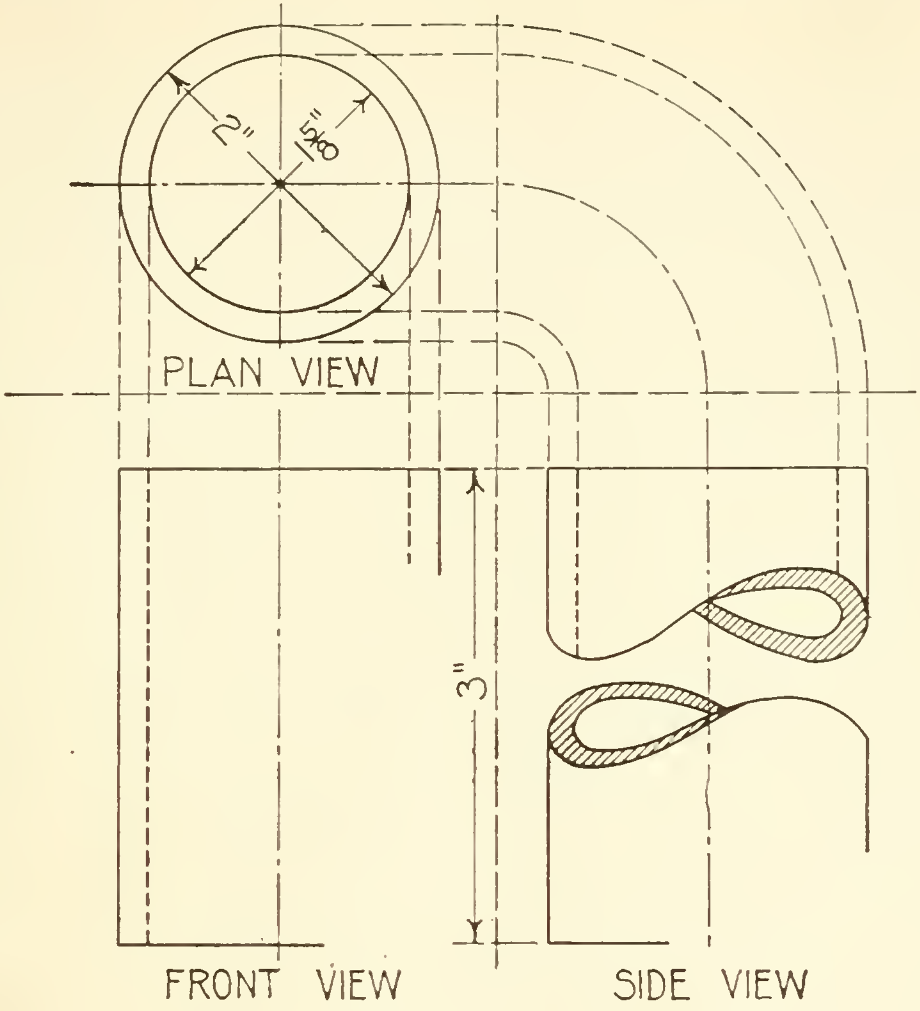
GEOMETRIC CONSTRUCTION
FOR IONIC VOLUTE

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 6
STUDY
NO.

PROBLEM 7. PROJECTION OF HOLLOW CYLINDER

The object of this drawing is to give practice in projection. The arrangement is merely suggested and you are expected to complete the drawing satisfactorily. Study carefully the chapter on projection before attempting this problem.

a. Lay out a standard sheet and complete the drawing of the hollow cylinder. Be sure that your drawing shows the object in correct straight-line projection in the third angle. The broken section in the view to the right helps to convey the idea that the cylinder is hollow. The curve is first outlined free-hand and is then gone over with the irregular curve. Show the dimensions on your drawing as given here.



PROJECTION OF HOLLOW CYLINDER

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 7
STUDY NO.

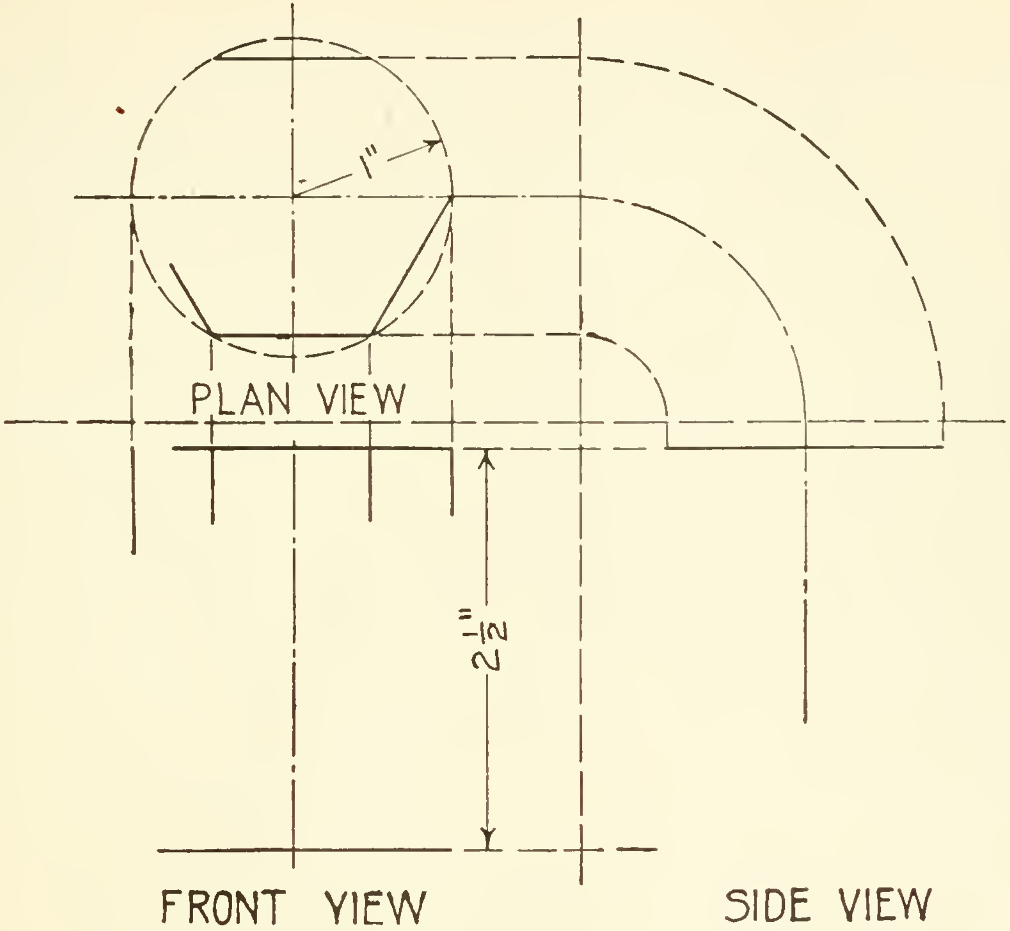
PROBLEM 8. PROJECTION OF HEXAGONAL PRISM.

This drawing is a continuation of the beginning work in projection. A hexagonal prism is a solid which has six rectangular planes for sides and two hexagonal planes for its bases. You are required to make a drawing of the prism in each of three different positions.

a. Lay out a standard sheet and complete the drawing of the hexagonal prism. Make sure that your drawing shows the object in correct straight-line projection in the third angle. Show the dimensions as given here.

b. Arrange the plan view so that the lower line of the hexagon makes an angle of 30° with the horizontal and complete the projection.

c. Arrange the vertical axis in the front view so that it makes an angle of 30° with the vertical and complete the projection.



PROJECTION OF HEXAGONAL PRISM

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. No. 8
STUDY NO.

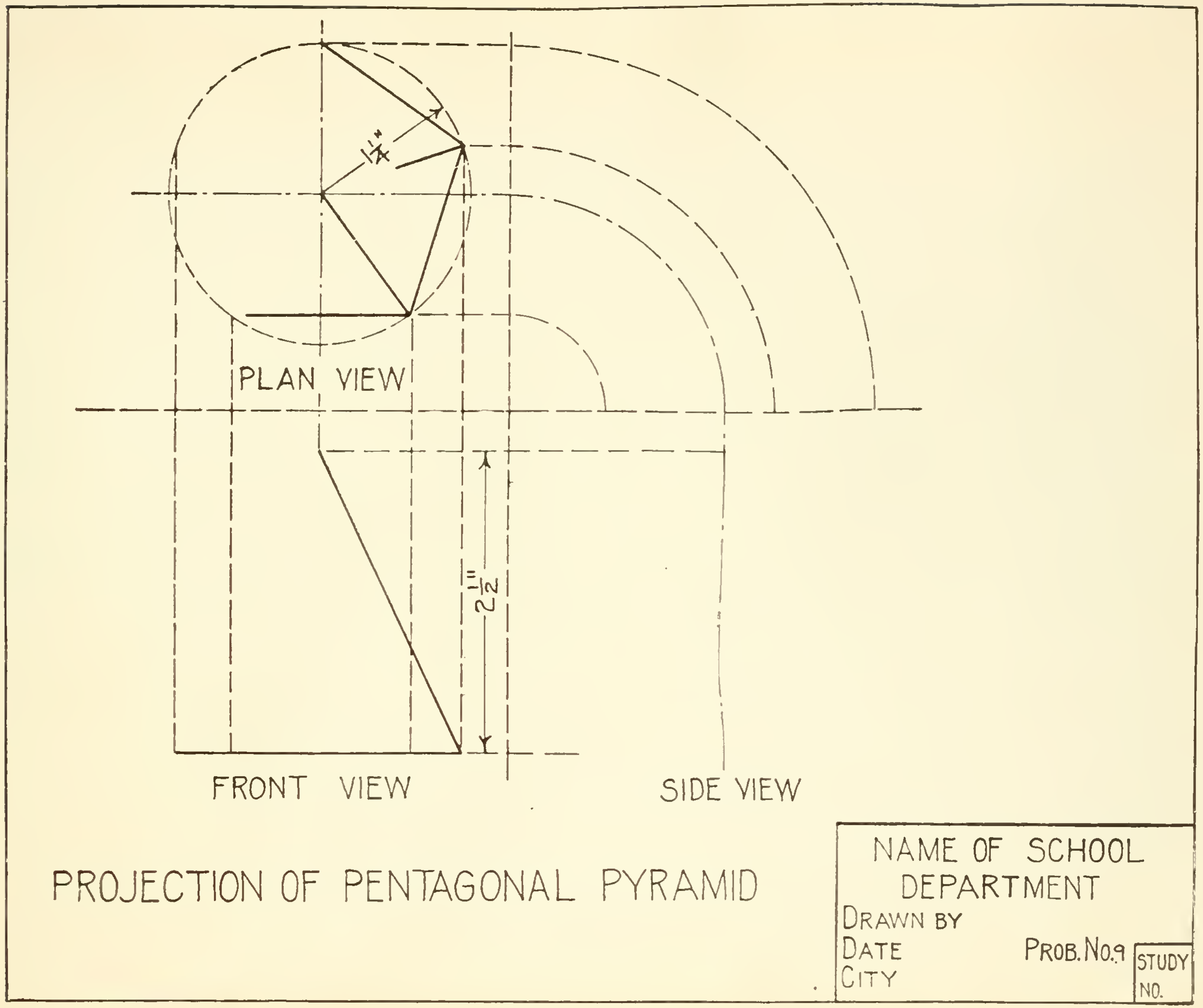
PROBLEM 9. PROJECTION OF PENTAGONAL PYRAMID

A pentagonal pyramid is a geometric solid which has five triangular planes for its sides and a pentagon for its base.

a. Lay out a standard sheet and complete the drawing of the pentagonal pyramid as shown in the accompanying drawing. Give the necessary dimensions.

b. Arrange the plan view so that the lower line of the pentagon makes any convenient angle, say 30°, with the horizontal. Complete the projection showing front view and side view.

c. Arrange the vertical axis so that it makes any convenient angle with the vertical and complete the projection of the plan and side views.



PROJECTION OF PENTAGONAL PYRAMID

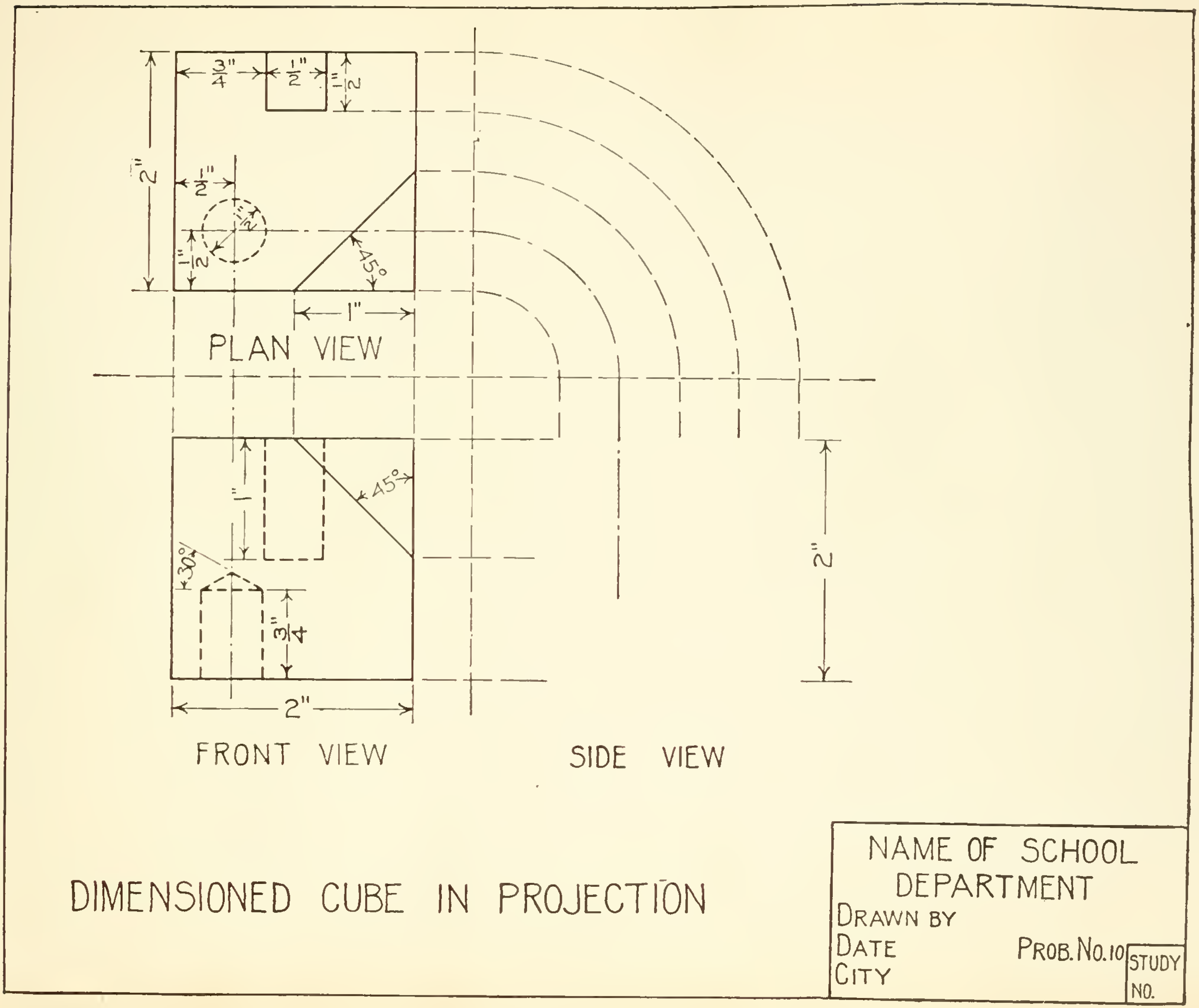
PROBLEM 10. DIMENSIONED CUBE IN PROJECTION

This drawing shows a cube, one corner of which has been removed, into the bottom of which a hole $\frac{1}{2}''$ in diameter has been bored to a depth of $\frac{3}{4}''$ and in the back of which a square slot has been cut for half the length of the block. This drawing gives practice in dimensioning as well as additional practice in projection.

a. Lay out a standard sheet and make three views of the cube as shown in the accompanying drawing. Complete the side view, being careful to show the cut-away corner, the bored hole and the square slot in their proper relation. Be especially careful with your measurements and dimension your drawing fully.

b. Make a drawing of a plain cube $2''$ on a side without the cut-away corner, hole or slot. Arrange the lower line of the square in the plan view so that it makes an angle, of 30° with the horizontal. Complete the front and side views.

c. Leaving the plan view as in (*b*), arrange the front view so that the vertical edges of the cube make an angle of 30° with the vertical. Make the necessary changes in the plan view and draw the side view with the cube in this position.


3"/4
1"/2
1"/2
2"
1"/2
1"/2
1"/2
45°
1"
PLAN VIEW
1"
45°
30°
3"/4
2"
2"
FRONT VIEW
SIDE VIEW
DIMENSIONED CUBE IN PROJECTION
NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 10
STUDY NO.

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ASTOR, LENOX
TILDEN FOUNDATIONS

PROBLEMS: PART II

MANUAL TRAINING DRAWING

TITLES

Problem 11. Halved Joint.
Problem 12. Free-hand Lettering.
Problem 13. Picture Frame.
Problem 14. Bracket Shelf.
Problem 15. Taboret.
Problem 16. Wash Bench.
Problem 17. Nail Box.
Problem 18. Tool Box.
Problem 19. Carpenter's Saw Horse.
Problem 20. Arm Chair.

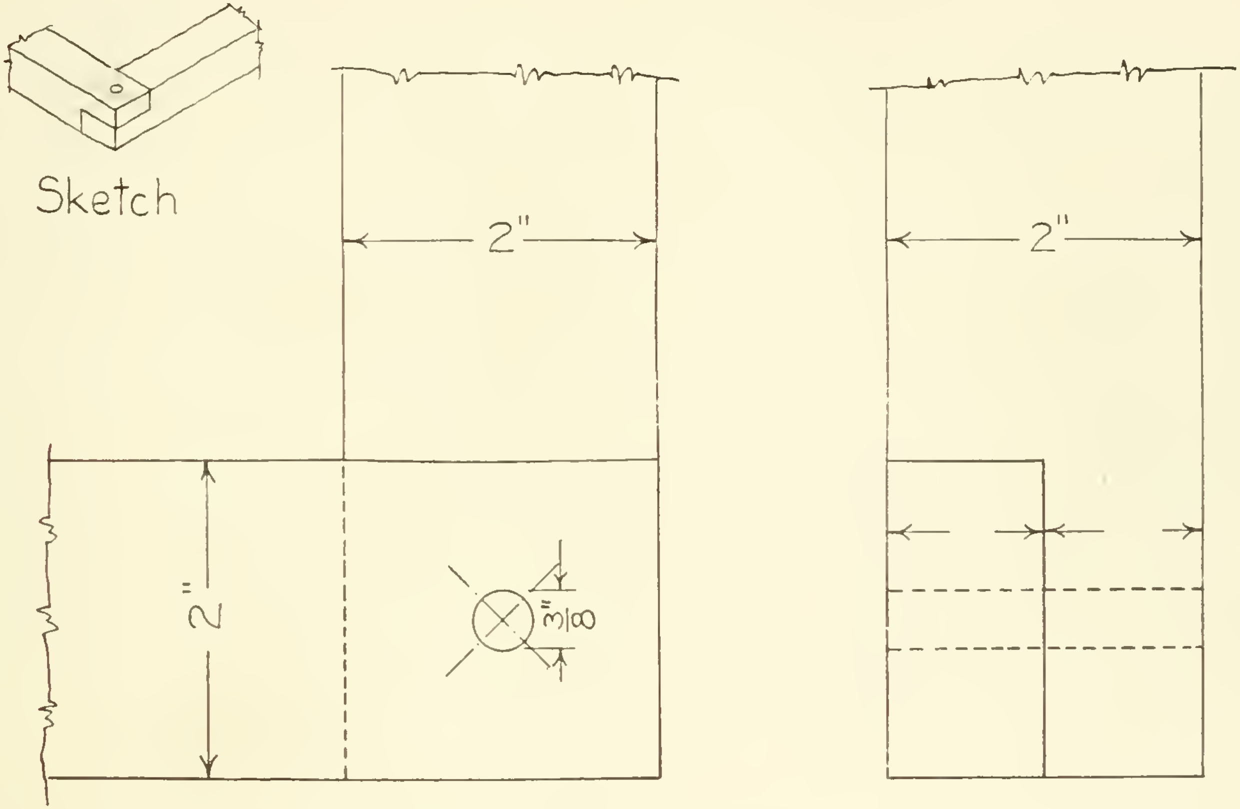
PROBLEM 11. HALVED JOINT

The sketch in the upper left-hand corner of the sheet shows a picture of the joint. One-half of the end of each stick is cut away and the sticks fitted together. A hole is bored through the center of the joint and a dowel pin inserted. The larger drawing shows two views of the joint in straight-line projection. The sizes of the sticks and the cuttings are indicated by dimension or witness lines and figures. The arrow heads show from where the dimensions are taken. For the view to the right the pin which passes through the joint is indicated by dotted lines. This is the common method of indicating lines that are not visible.

a. Copy the straight-line drawing as it is. Use the full size scale for laying out the dimensions and make the drawing the full size of the actual piece. Do not measure the accompanying drawing but use your scale for laying out. Supply the missing figures in the view to the right. Do not copy the sketch in the upper left-hand corner.

b. It is seldom necessary in woodworker's drawing to make a drawing of each separate piece, but it is a good thing to know how to do it. Make a drawing of one of the sticks properly cut and bored. Dimension your drawing.

c. Make a similar drawing of a through mortise and tenon joint with a dowel pin. Use the same size sticks. Show two views and dimension your drawing fully.



HALVED JOINT

Scale in Inches

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 11
STUDY NO.

PROBLEM 12. FREE-HAND LETTERING

There is probably no one thing that causes so much difficulty to start with as the lettering. The first attempts at lettering are likely to be crude, but with conscientious practice much improvement may be made. The beginner's most common faults are to make the letters too narrow and to space them too far apart.

Be sure to occupy a comfortable position when lettering or drawing. Do not cramp the body or the hand. Make each stroke with uniform pressure. Study carefully the shape and proportions of the letters as shown in the sample. Use a fairly soft lead pencil with a sharp conical point. When inking, use a Gillott's Steel Pen, No. 303 or 404. Be sure to follow the guide lines carefully.

a. Rule off a standard sheet in guide lines for letters. Make the capital letter $\frac{3}{16}$ inch high and allow $\frac{3}{16}$ inch between the lines of the letters. With a sharp pencil practice making the letters of the alphabet in both upper and lower case. When the sheet is filled, hand it in to the teacher for criticism and suggestions. Copy any portion of the text for material to fill in the sheet with lettering.

b. If more practice is desired, rule off another sheet and repeat the work, paying particular attention to the suggestions received from your instructor on the previous sheet. Use any material that may suggest itself for the composition work.

c. Ink the work of *a* or *b*. Hand in all of the sheets to your instructor including those which you have made for practice.

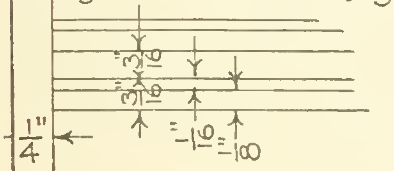
ABCDEFGHIJKLMNOPQRSTUVWXYZ - 1234567890 - ABCDEFGHIJKLMNOPQRSTU

abcdefghijklmnopqrstuvwxyz - $3\frac{1}{2}''$ 6 ft 9$\frac{3}{16}''$ |← $5\frac{1}{16}''$ →|← 1 ft 4" →| 31 Aug. 1915

Space the letters close together Allow ample space between words. Fill up this sheet with any material that may suggest itself

ABCDEFGHIJKLMNOPQRSTUVWXYZ - 1234567890 - SLANTING FREEHAND -

abcdefghijklmnopqrstuvwxyz - $3\frac{1}{2}''$ 6 ft 9$\frac{3}{16}''$ - Use vertical or slanting letters according to choice. FOR DISTANCE READING USE ALL CAPITALS. For easy reading at close range use lower case letters.



These lines show the correct spacing for the letters.

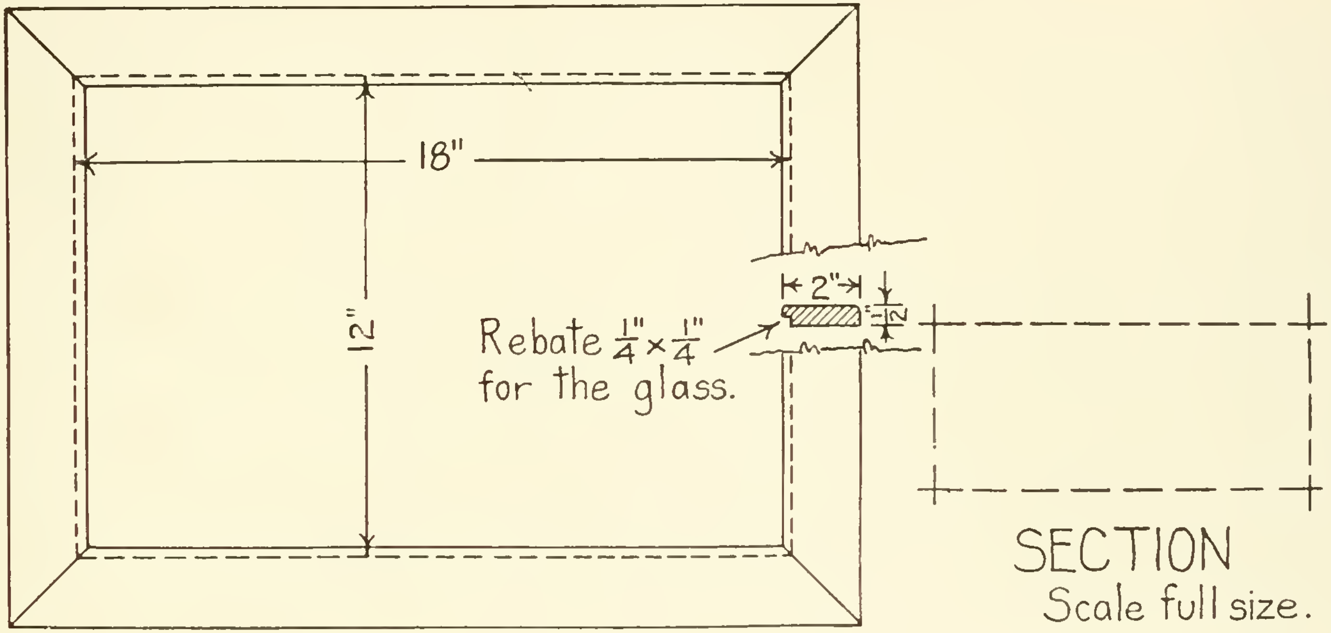
NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 12
STUDY NO.

PROBLEM 13. PICTURE FRAME

This drawing shows a picture frame with mitered joints. The glass size is 12″×18″ but it would be impossible to show the object in its full size on this size sheet. For this reason the drawing is *scaled down* to one-quarter of the true size of the object. In order to show the shape of the moulding a representation of a section cut through the frame at right angles is shown at the right where the frame is shown as being broken away.

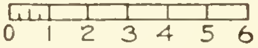
a. Make a drawing similar to the one shown but do not break away the frame at the right for the section. Instead show a full-size section of the mould in the space indicated in the drawing. Do not show a line around the section in your drawing.

b. Make a frame of 12″×18″ glass size but show a different shaped moulding. Be sure to use a shape that looks well and is practical. Dimension your drawing fully.



PICTURE FRAME

SECTION
Scale full size.



Scale in Inches

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 13
STUDY NO.

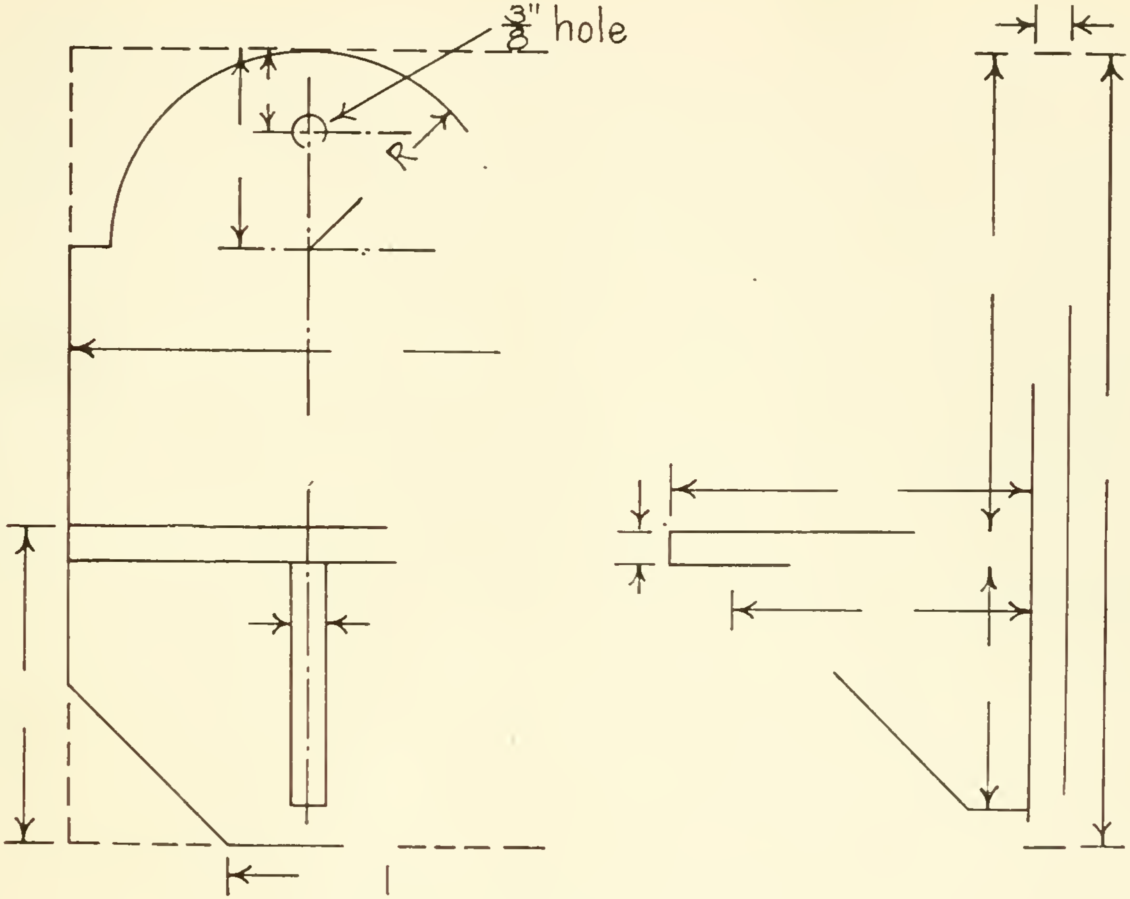
PROBLEM 14. BRACKET SHELF

This problem shows a straight-line drawing for a bracket shelf. The drawing is not complete and many of the lines are merely suggested. All of the dimensions are indicated but the figures are not given. The student is expected to complete the drawing and supply the missing dimensions.

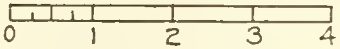
a. Make a drawing of the bracket shelf and complete it. Supply all the indicated dimensions in inches. Put in the full-size figures, but make the drawing one-half size.

b. Make a similar drawing of a bracket shelf but having a provision for a small mirror about 6″×8″ in the upright portion. Dimension the drawing fully.

c. Make a similar drawing of a bracket shelf suitable for a clock. The shelf should be about 6″ wide and 10″ long. In this case it would be well to omit the upper portion of the back and to supply two brackets. Dimension the drawing fully.



BRACKET SHELF



Scale in Inches

NAME OF SCHOOL
DEPARTMENT
DRAWN BY
DATE
CITY
PROB. NO. 14
STUDY NO.

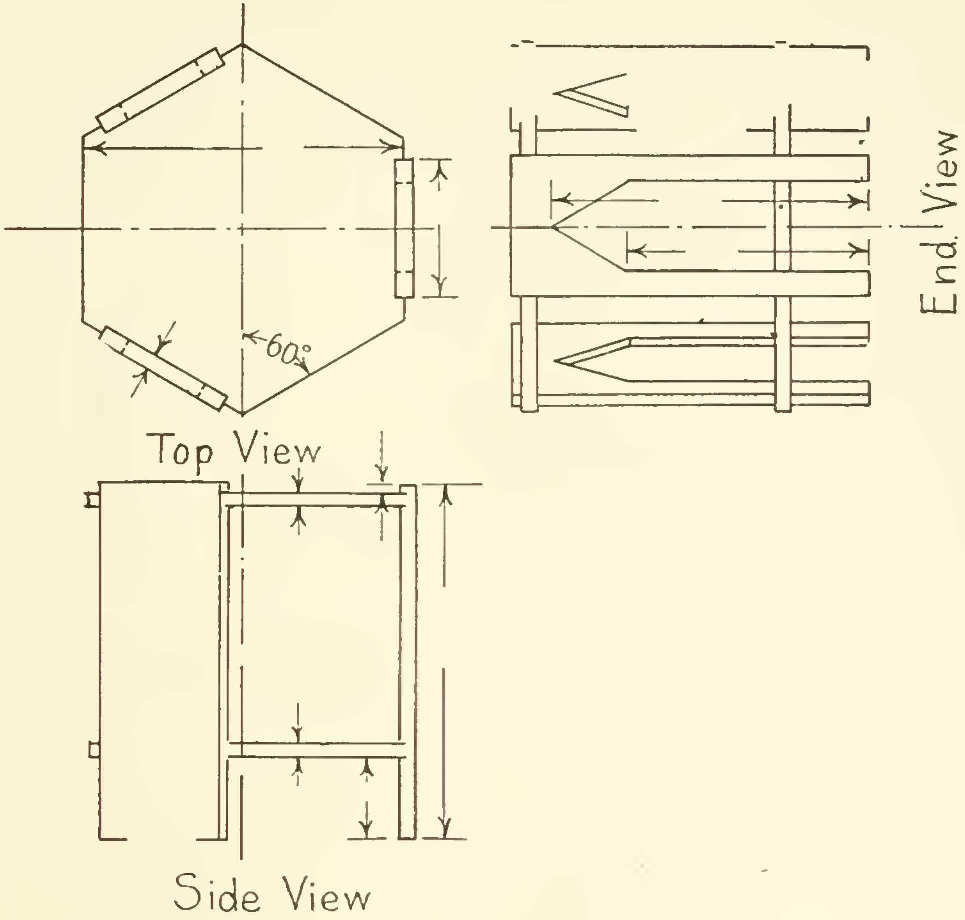
PROBLEM 15. TABORET

A small taboret is a convenience in any household. The hexagonal form, while it is somewhat harder to construct, is worth while because of its added beauty. Another improvement would be to cut out the legs in semicircular form at the top.

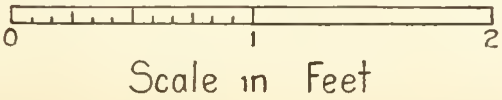
a. Make a complete drawing similar to the one shown but put the end view to the right of the side view. Complete the side view by showing the cuttings in the legs. Supply all the dimensions indicated. Make the drawing one-eighth size or $1\frac{1}{2}'' = 1$ ft.

b. Follow the directions in *a* but show the leg pieces cut in a semicircle at the top.

c. Make a detail drawing of each separate part.



TABORET



NAME OF SCHOOL
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DATE
CITY
PROB. NO. 15
STUDY NO.

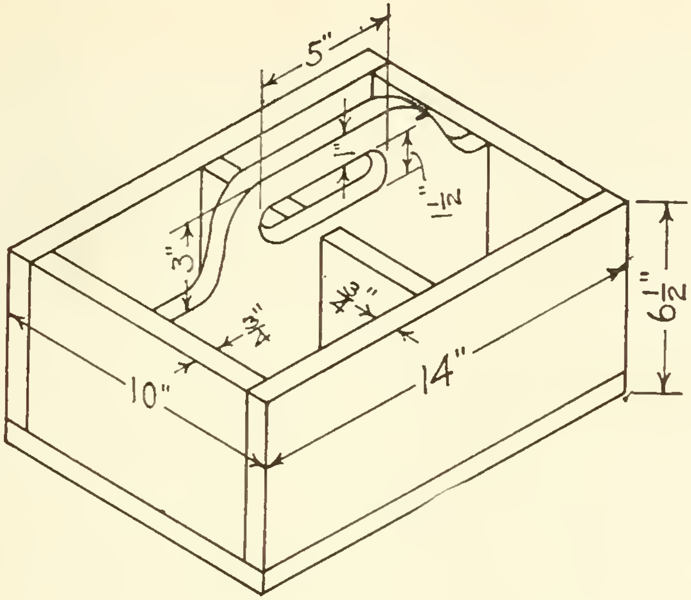
PROBLEM 16. NAIL BOX

For the woodworker or for the amateur hewer of woods a nail box is a very useful article. It should be divided into a number of compartments to keep the different sizes of nails separate.

a. Make a complete straight-line drawing of the nail box showing a top view, a side view and an end view. Show everything complete and dimension your drawing fully. Do not copy the sketch. Use $\frac{3}{16}'' = 1''$ scale.

b. Make a straight-line drawing of a nail box having six compartments instead of four. Make a complete drawing.

c. Make a detail drawing of each piece in the nail box, showing how it is to be cut. Name the pieces. Use a scale that will permit you to get all of the pieces on a single sheet.



Top View

Side View

End View

NAIL BOX

NAME OF SCHOOL
DEPARTMENT
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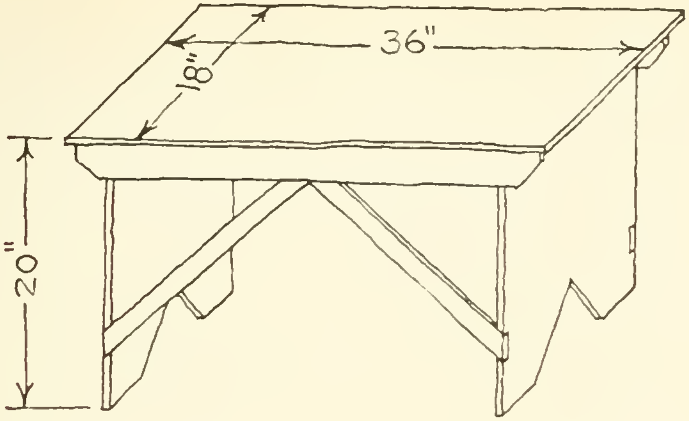
CITY
PROB. NO. 16
STUDY NO.

PROBLEM 17. WASH BENCH

Every completely furnished home must be supplied with a wash bench. The sketch shown herewith is not very satisfactory for the carpenter to work from because it does not show the bench in its true shape, or give all the necessary information as to the proper size of boards to use nor how to cut them.

a. Make a straight-line drawing of the wash bench showing side view and end view. Show everything complete and dimension your drawing properly. Do not copy the sketch. Use $1\frac{1}{2}'' = 1$ ft. scale.

b. Make a straight-line drawing of a piano bench. Provide a compartment under the seat board in which sheet music may be kept. Make your design simple but in good taste. Be sure that your bench will be substantial when it is made. Give complete information on your drawing, including dimensions.



Sketch of Wash Bench

Side View

End View

WASH BENCH

NAME OF SCHOOL
DEPARTMENT
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DATE
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PROB. NO. 17
STUDY NO.

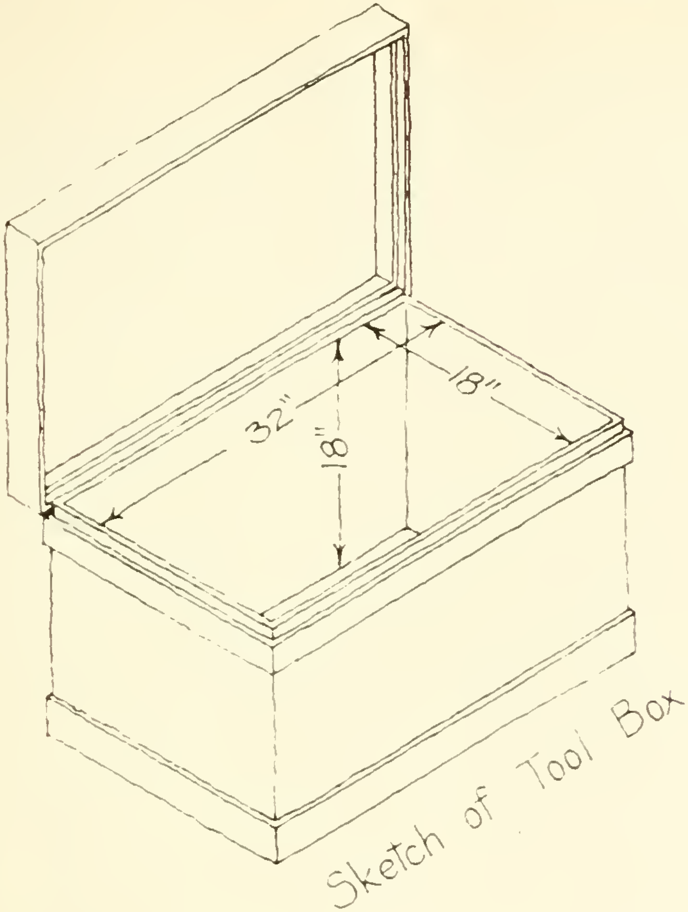
PROBLEM 18. TOOL BOX

Every mechanic appreciates a nice box in which to keep his tools. A good tool box should be substantial but not too heavy. The box shown in the sketch might easily be provided with a tray for small tools.

a. Make a complete drawing of the tool box showing a side view and an end view. A sectional view through a portion of the lid and through the upper edge of the box would add to the clearness. This section might be shown in a manner similar to the section of the picture frame mould shown in Problem 13. Dimension your drawing fully. Do not copy the sketch. Use $1\frac{1}{2}'' = 1$ ft. scale.

b The carpenter likes to have a smaller, lighter box than this in which he can carry his most necessary tools about with him. It should be long enough and deep enough to accommodate his hand saws but not so wide nor heavy as to prevent him from carrying it on his shoulder for short distances. Make a drawing of such a box.

c. A more elaborate case is one in which every tool has a compartment. The shape is similar to the one illustrated but the front is hinged instead of the top. When the box is opened a number of drawers and compartments are exposed. Make a complete dimensioned drawing of such a case. Show how the drawers are constructed and give all necessary information.



Side View

End View

TOOL BOX

NAME OF SCHOOL
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PROB. NO. 18
STUDY NO.

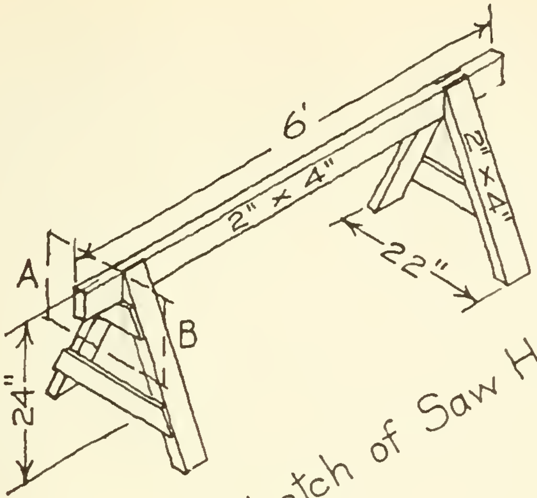
PROBLEM 19. CARPENTER'S SAW HORSE

The carpenter's saw horse is a very useful wooden appliance. The carpenter usually makes his accessories of this nature, such as ladders, scaffold, brackets, benches, etc.

a. Make a complete dimensioned drawing of the saw horse, including a side view, an end view and a large scale detail of the joint. Do not copy the sketch. Use $\frac{3}{4}''=1$ ft. scale.

b. Make a drawing of a carpenter's work bench about 10 feet long and about 27 inches wide. Be sure to make it the proper height for comfort. Provide for bench vise at one end. Use a commercial size of lumber. Give all necessary information and dimension the drawing completely.

c. Make a drawing of a step-ladder about 8 feet high. The side pieces and back legs may be $1''\times 6''$ boards as may also the steps. The back legs may be arranged to fold or the latter may be rigid with the back legs vertical. The ladder should be well braced and substantial.



Sketch of Saw Horse

Detail of Joint at A-B

Side View

End View

CARPENTER'S SAW HORSE

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PROB. NO. 19
STUDY NO.

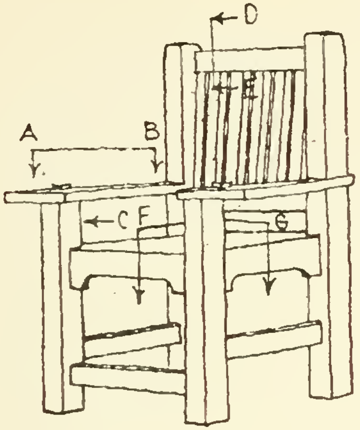
PROBLEM 20. ARM CHAIR

Home-made furniture is much appreciated if it is well made. This arm chair in the mission style is well proportioned and quite easy to build. The seat should be provided with a leather cushion.

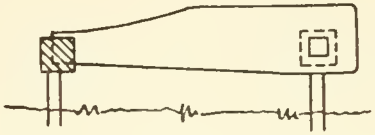
a. Make a complete dimensioned drawing of the arm chair, including a front view, a side view and the detail and section views indicated. Be sure to choose the dimensions carefully and to make everything fit together properly. Do not omit any essential information. Use 1″ = 1 ft. scale.

b. Make a complete drawing of a Morris chair in the mission style. To get the ideas you might be able to examine such a chair at home or at the furniture dealers. Pay particular attention to the hinged back. Both the back and the seat are to be provided with leather cushions.

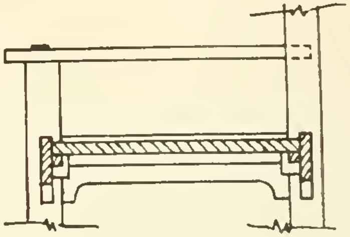
c. Make a complete drawing of a davenport in the mission style. The general arrangement might be similar to the arm chair illustrated, except that the ends should be high like the back.



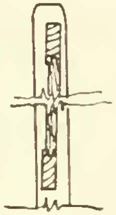
Sketch of Arm Chair



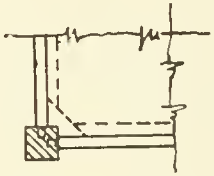
Plan of Arm at A-B



Detail at C



Section D-E



Section F-G

ARM CHAIR
MISSION STYLE

Front View

Side View

NAME OF SCHOOL
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PROB. NO. 20
STUDY NO.

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PROBLEMS: PART III

BUILDING DETAILS

TITLES

Problem 21. Detail of Bracket.
Problem 22. Architectural Free-Hand Lettering.
Problem 23. Some Modern Mouldings.
Problem 24. Detail of Baluster.
Problem 25. Double Swinging Doors for Warehouse.
Problem 26. Box Sill Construction.
Problem 27. Detail of Cornice Construction.
Problem 28. Detail of Medicine Case.
Problem 29. Detail of Cellar Window.
Problem 30. Details for Double-Hung Window.

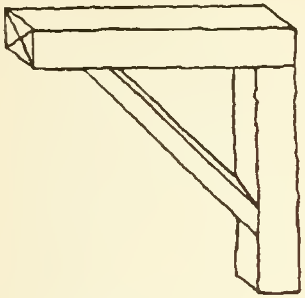
PROBLEM 21. DETAIL OF BRACKET

The drawing shows a bracket such as might be used for supporting the overhanging eaves of a house or the canopy for an entrance. It is in three pieces joined together with mortise joints. The sketch in the upper left-hand corner shows how the object would appear to the eye. The large drawing is a straight-line projection drawing with dimensions such as would be used by a carpenter in making the bracket.

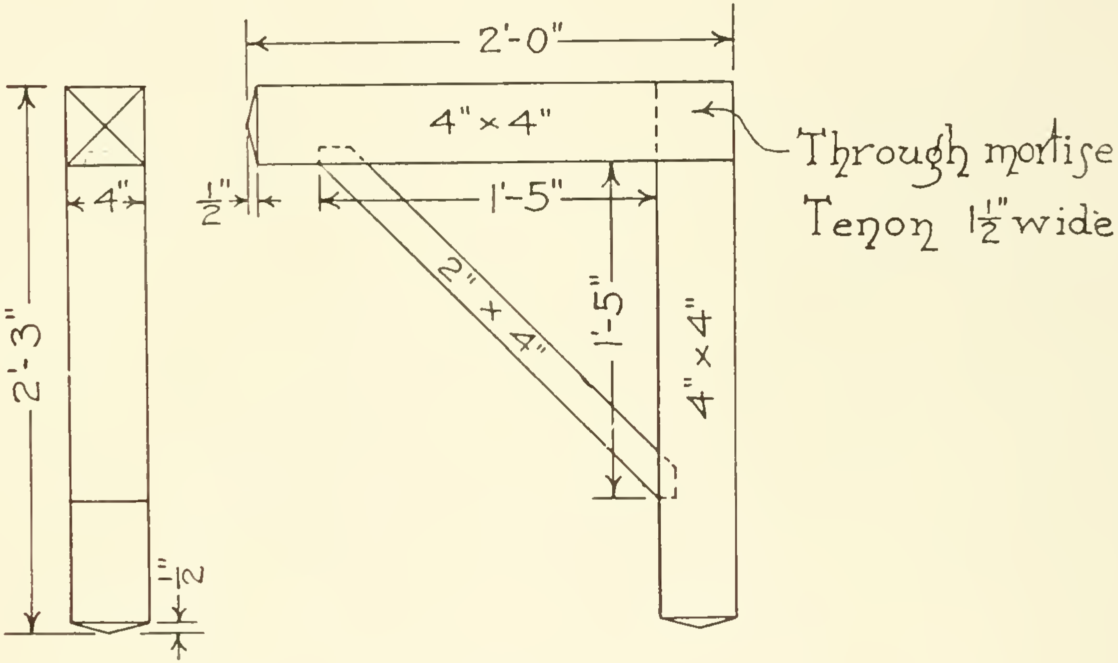
a. Copy the straight-line drawing as it is. Use the $1\frac{1}{2}''$ scale to lay out the dimensions. Do not measure the accompanying drawing but take all the dimensions from the figures. Put figures on your drawing in exactly the same manner as those shown in the sample. Do not copy the sketch in the upper left-hand corner. Use $1\frac{1}{2}'' = 1$ ft. scale.

b. Make a drawing of a bracket which is similar to the one shown but in which the diagonal brace is curved in the arc of a circle.

c. Make a straight-line drawing of each piece of the bracket, showing exactly how they are to be cut for the joints.



Sketch of the Bracket



Detail of Bracket

Scale in Feet

NAME OF SCHOOL
DEPARTMENT
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Date Prob.No.21a
City
Study No.

PROBLEM 22. ARCHITECTURAL FREE-HAND LETTERING

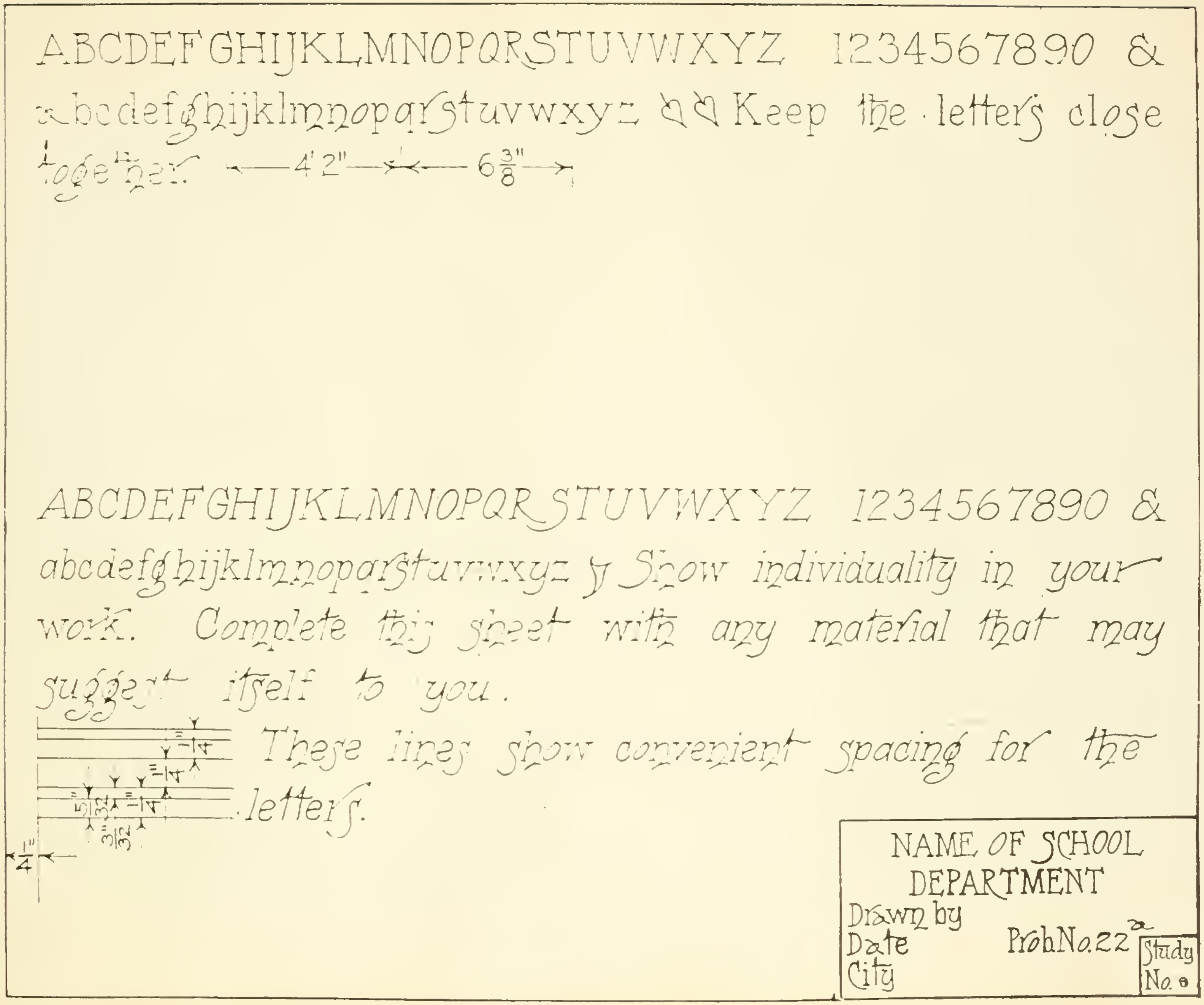
The appearance of a drawing depends very largely upon the character and neatness of the lettering. It is necessary for the draftsman to letter both rapidly and well. The ability to letter well comes through practice. The first attempts will probably not be very successful but the beginner must not be discouraged.

A few hints may be helpful. Do not cramp the body or sit in an awkward position. Hold the pen freely in the hand, being careful not to cramp the fingers. Make each stroke with uniform pressure. Use a 2H pencil with a conical point. For the ink work use a Gillott's 303 or 404 steel pen. Follow the guide lines carefully. Examine the exact form of the letters in the sample and try to make your letters like them. Keep the letters of a word close together but be sure to allow sufficient space between words.

a. Rule off a standard sheet in guide lines for letters similar to the ruling shown in the sample and with a soft pencil practice making the alphabets. When the sheet is filled, hand it in. Copy any portion of the text for material with which to fill out the sheet.

b. If the work in *a* is not satisfactory or if more practice is desired, rule another sheet and repeat the work, paying particular attention to the criticisms received on the previous work.

c. With a pen and ink go over the work of *a* or *b*. Hand in all of the work, including the practice sheets.



ABCDEFGHIJKLMNOPQRSTUVWXYZ 1234567890 &

abcdefghijklmnopqrstuvwxyz & & Keep the letters close together.

←4' 2"→←6 3/8"→

ABCDEFGHIJKLMNOPQRSTUVWXYZ 1234567890 &

abcdefghijklmnopqrstuvwxyz & Show individuality in your work. Complete this sheet with any material that may suggest itself to you.

These lines show convenient spacing for the letters.

1/4"
1/4"
1/4"
5/32"
3/32"
3/32"
1/4"

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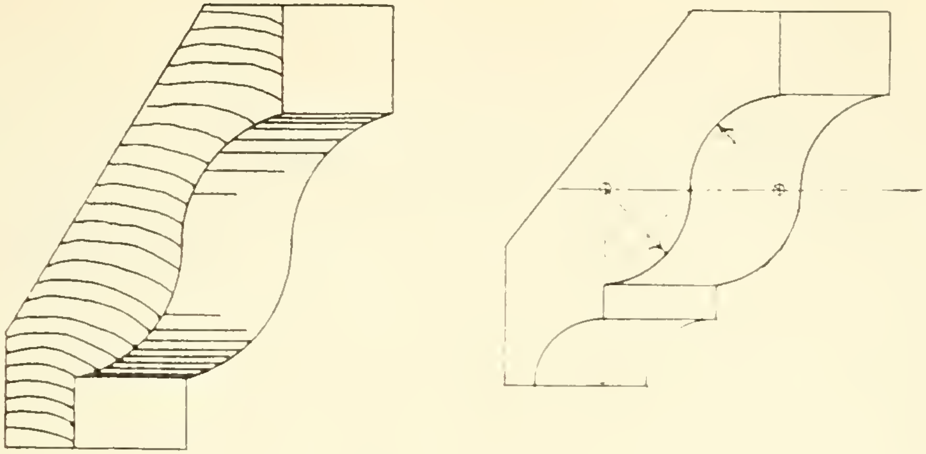
PROBLEM 23. SOME MODERN MOULDINGS

This problem gives practice in the combination of curves and straight lines. These are sections of stock mouldings. A book illustrating stock mouldings may be obtained from any sash and door factory and is very useful for reference.

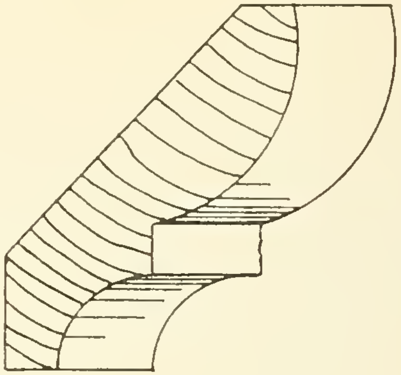
a. Make a drawing exactly like the samples. Notice particularly the method of constructing the curves. Every curve shown may be drawn with the compass, but great care must be used to get them exactly right. The graining is put in free hand but the shadows are made with a straightedge. Use full-size scale.

b. Obtain short samples of various kinds of mouldings from a lumber yard or by visiting a new building. Measure them and make a full-size drawing of them similar to the one shown.

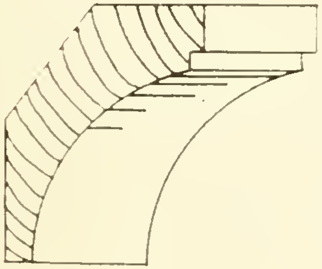
c. Select similar mouldings from a stock book and make drawings of several of them. Give the official number of the moulding.



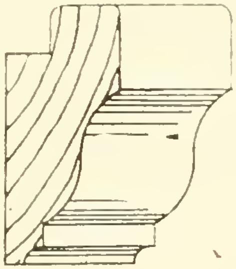
Crown Moulds



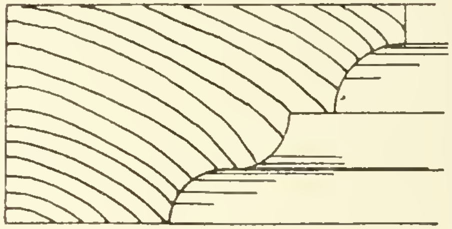
Bed Mould



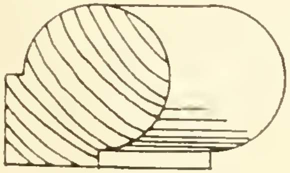
Cove Mould



Picture Mould

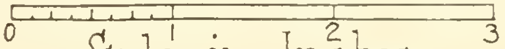


Cap Mould



3-Quarter Round

Some Modern Mouldings



Scale in Inches

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 23$^{\text{rd}}$
Study No.

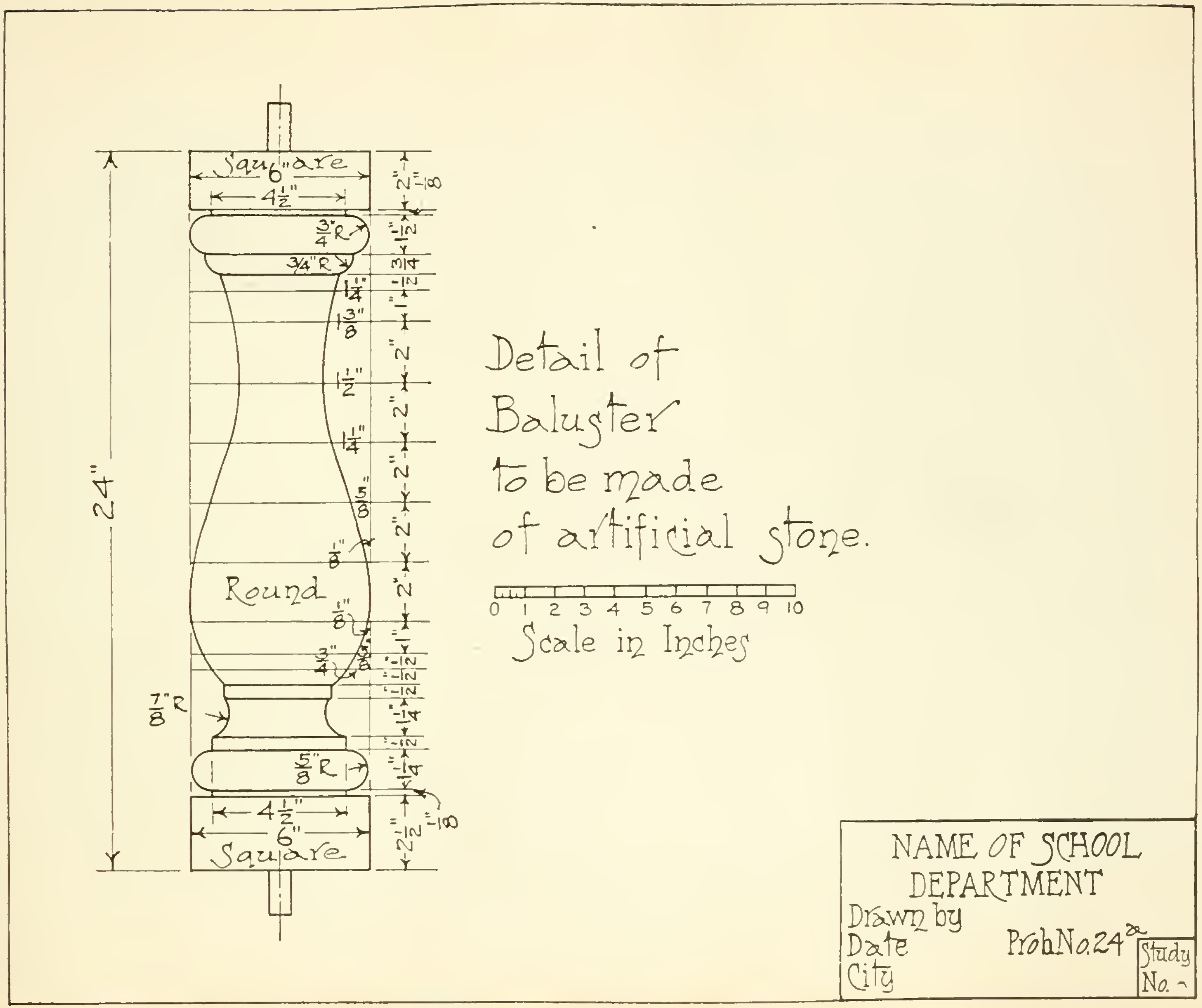
PROBLEM 24. DETAIL OF BALUSTER

This problem gives a method of showing and dimensioning an irregular curve and gives practice in the use of the French curve.

a. Make a drawing exactly like the one shown. Do not measure the drawing but get your information entirely from the figures. Do not put any dimensions on your drawing. Use 3″ = 1 ft. scale.

b. Measure any baluster or turned post to which you have access and make a scale drawing of it. Choose one which has an irregular curve.

c. Shade the outline of either of the above drawings by making the right-hand and lower edges about twice as heavy as the lines used on the left and upper edges. The light is supposed to come at an angle of 45° from the upper left corner.

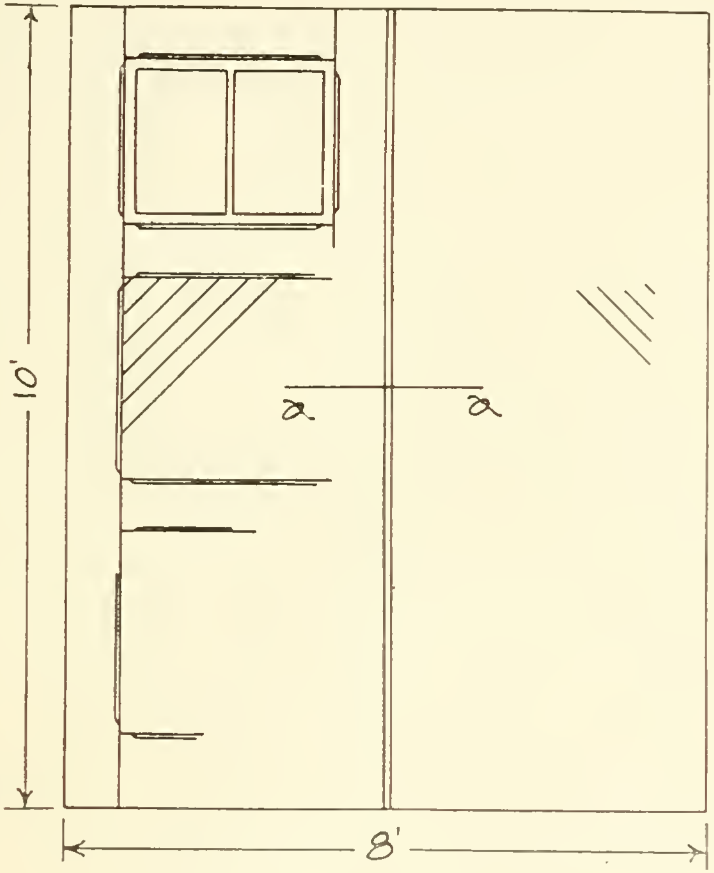

Square
6"
4½"
2⅛"
¾"R
3/4"R
1½"
¾
½
1"
1¼"
1⅜"
2"
1½"
1¼"
5/8"
1/8"
24"
Round
1/8"
3/4"
7/8"R
5/8"R
4½"
6"
Square
2⅛"
Detail of
Baluster
to be made
of artificial stone.
0 1 2 3 4 5 6 7 8 9 10
Scale in Inches
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob.No.24a
Study
No. -

PROBLEM 25. DOUBLE SWINGING DOORS FOR WAREHOUSE

The doors shown in the problem are double swinging doors such as might be used in a warehouse or garage. The doors might be jointed in a mill or the work might be done by hand. An astragal, a sort of moulding to cover the crack, must be provided between the two doors.

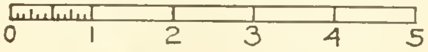
a. Complete the drawing and dimension it, showing the width of the stiles and rails, size of openings for panels, and size of glass required. The stock should be $1\frac{3}{4}''$ thick. Dimension your drawing fully. Use $\frac{1}{2}'' = 1$ ft. scale for the doors and $3'' = 1$ ft. for the section.

b. Measure a similar door, either swinging or sliding, to which you have access and make a drawing of it.



Section thru x-x

Double Swinging Doors for Warehouse



Scale in Feet

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob No. 25^{x}
Study No.

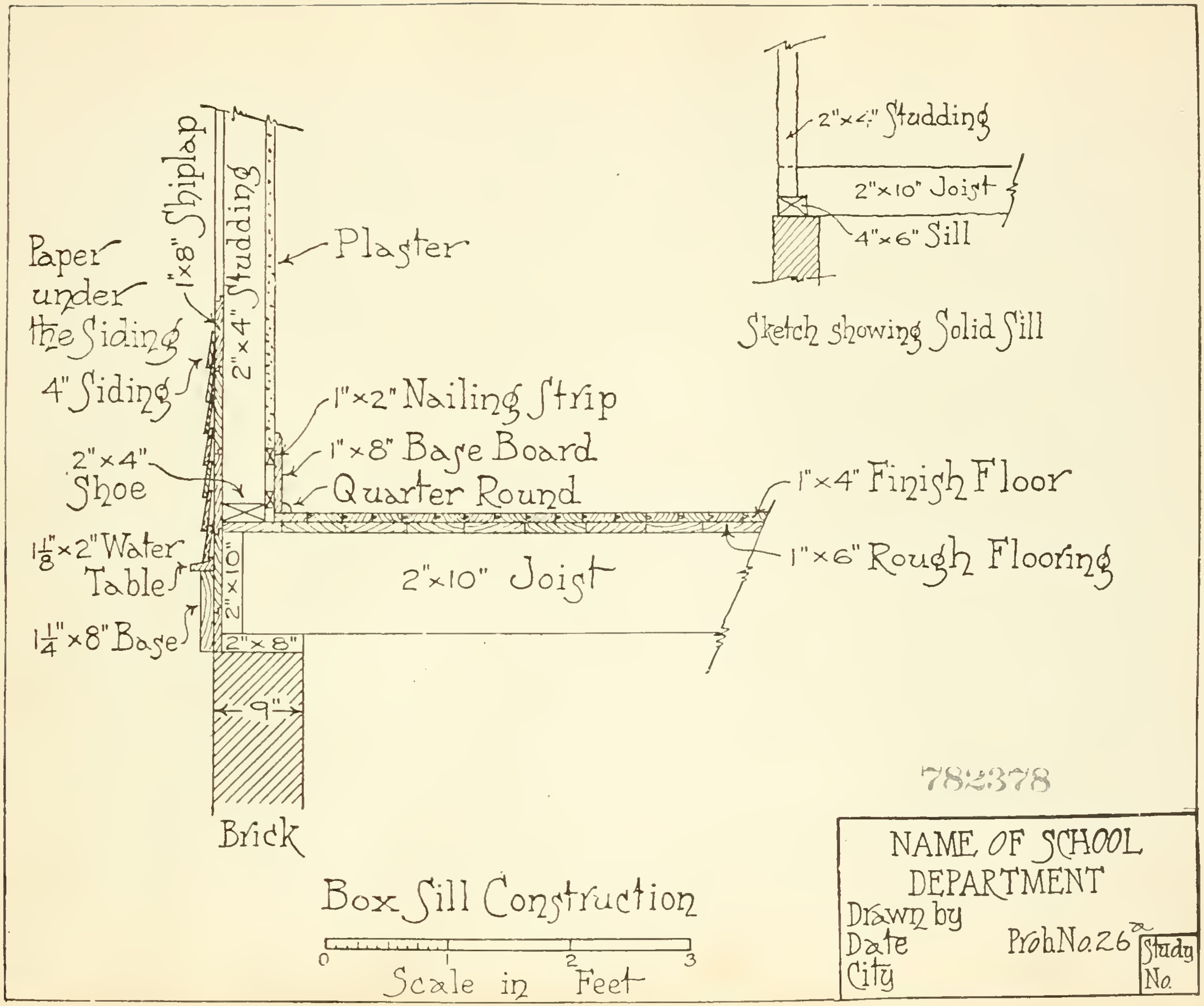
PROBLEM 26. BOX SILL CONSTRUCTION

This problem shows a section through a typical box sill for a frame dwelling house. Nominal sizes of lumber are indicated, it being understood that the nearest commercial sizes will be used. The fact that this construction is shown here does not necessarily mean that it is the best. This construction is conservative and satisfactory in use.

a. Make a drawing exactly like the one shown. Use 1″ = 1 ft. scale.

b. Make a drawing similar to the one shown but using a 4″×6″ solid sill as shown in the sketch in the upper right-hand corner. Do not copy the sketch.

c. Make a drawing of any other frame sill construction with which you are familiar. Do not show anything but the best modern practice.



Sketch showing Solid Sill

Box Sill Construction

Scale in Feet

782378

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City
Prob. No. 26a
Study No.

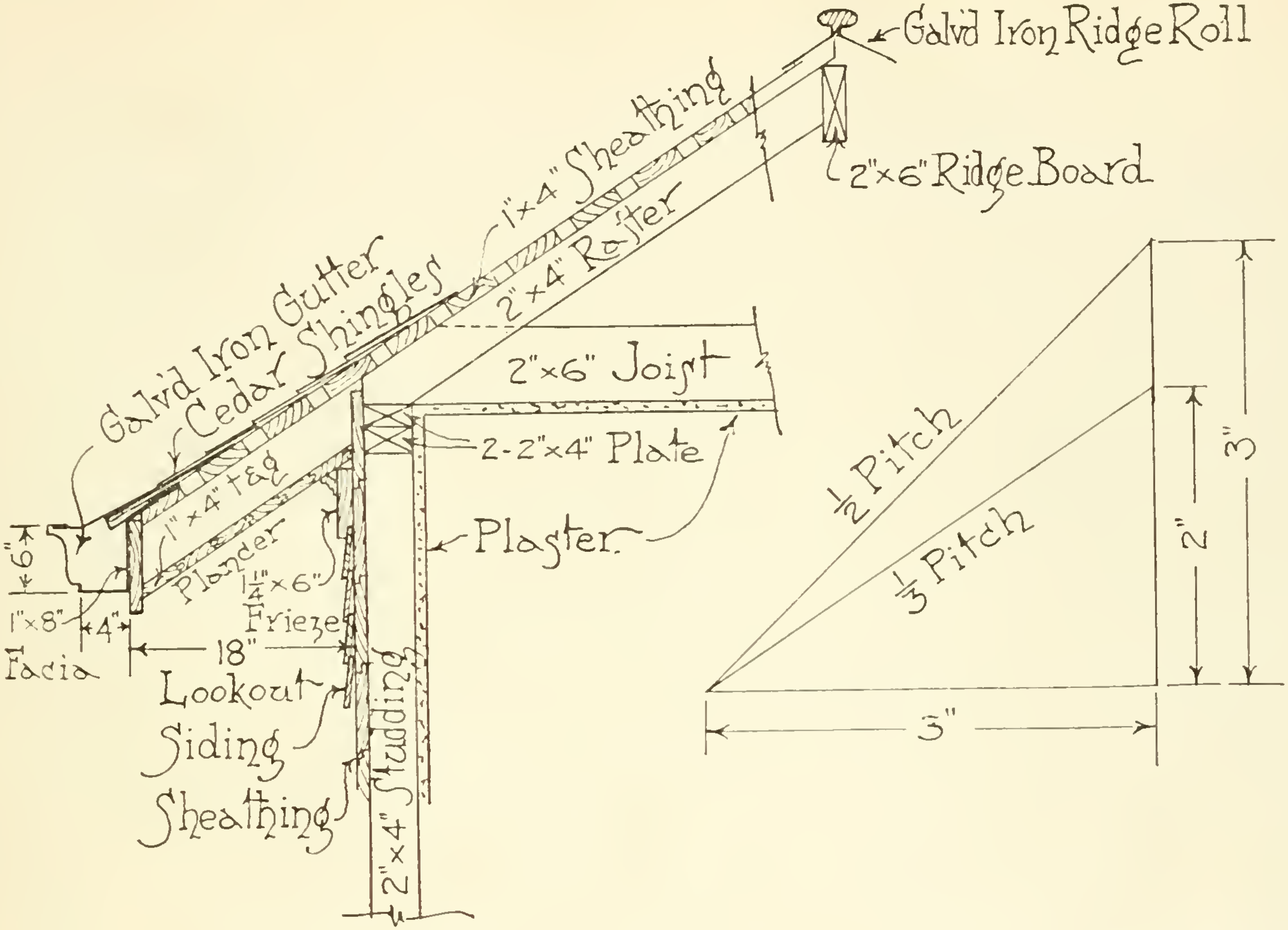
PROBLEM 27. DETAIL OF CORNICE CONSTRUCTION

This drawing shows a section through a typical cornice with a hanging gutter. This is a type of construction now being used to a large extent in modern frame construction. The diagram to the right shows how to find the correct pitch for the roof.

a. Make a drawing similar to this but show the roof at one-half pitch instead of one-third pitch. Do not copy the diagram. Use 1″ = 1 ft. scale.

b. Make a drawing showing a section of a typical cornice with exposed rafter ends and with the gutter placed on the roof.

c. Make a drawing of a typical cornice showing a horizontal planceer or soffit and a built-in box gutter.



Detail of Cornice Construction

0 1 2 3

Scale in Feet

NAME OF SCHOOL
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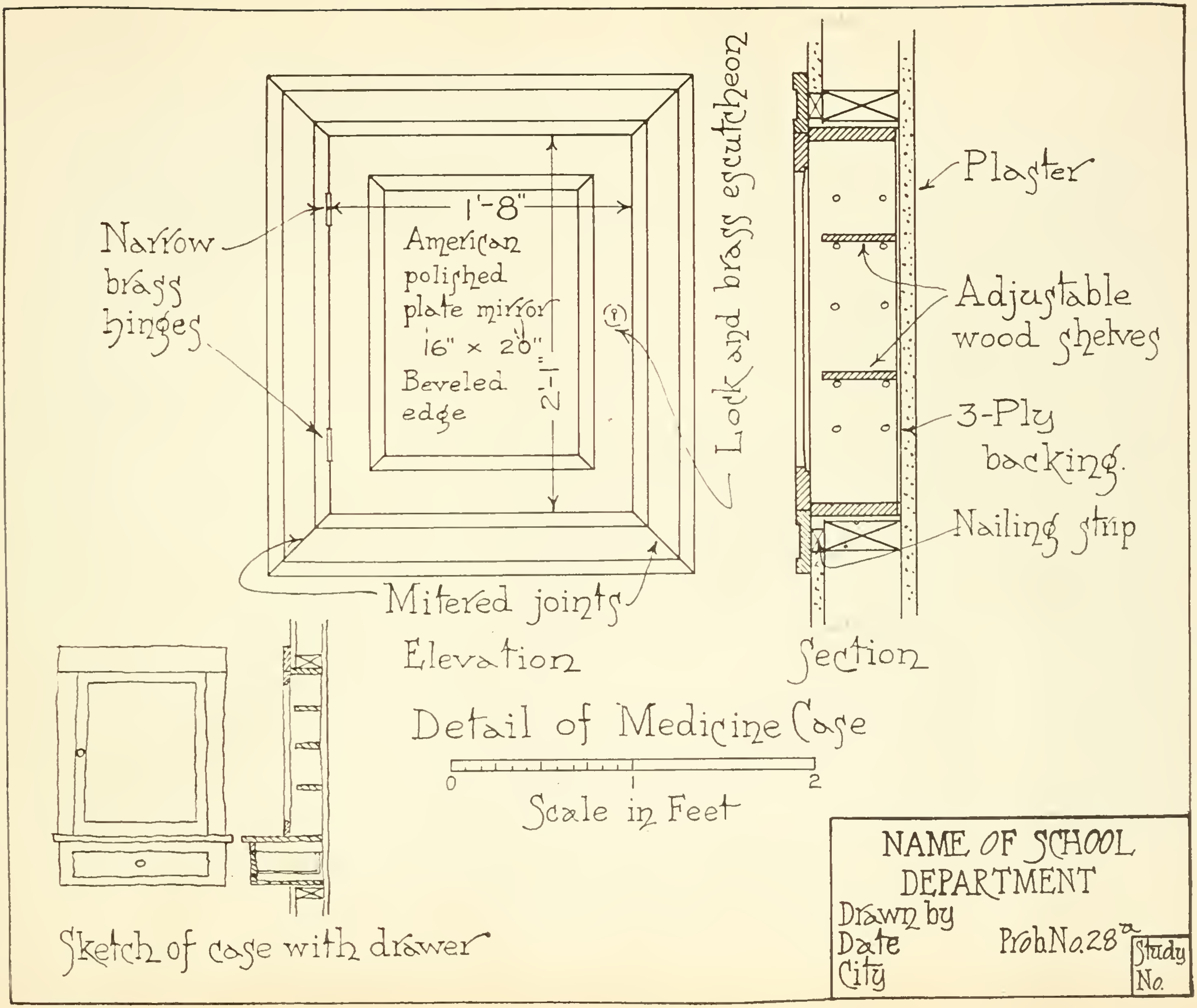
Drawn by
Date
City
Prob. No. 27a
Study No.

PROBLEM 28. DETAIL OF MEDICINE CASE

A medicine case is a convenient accessory in the bathroom. This case occupies merely the thickness of the wall.

a. Make a similar drawing, giving complete dimensions. Make the opening 1′ 10″×2′ 4″ and show that the door swings to the right. Use $1\frac{1}{2}''=1$ ft.

b. Make a detail drawing of a medicine case with a shelf and drawer below, as shown in the sketch in the lower left-hand corner. Dimension your drawing fully. Do not copy the sketch.



Detail of Medicine Case

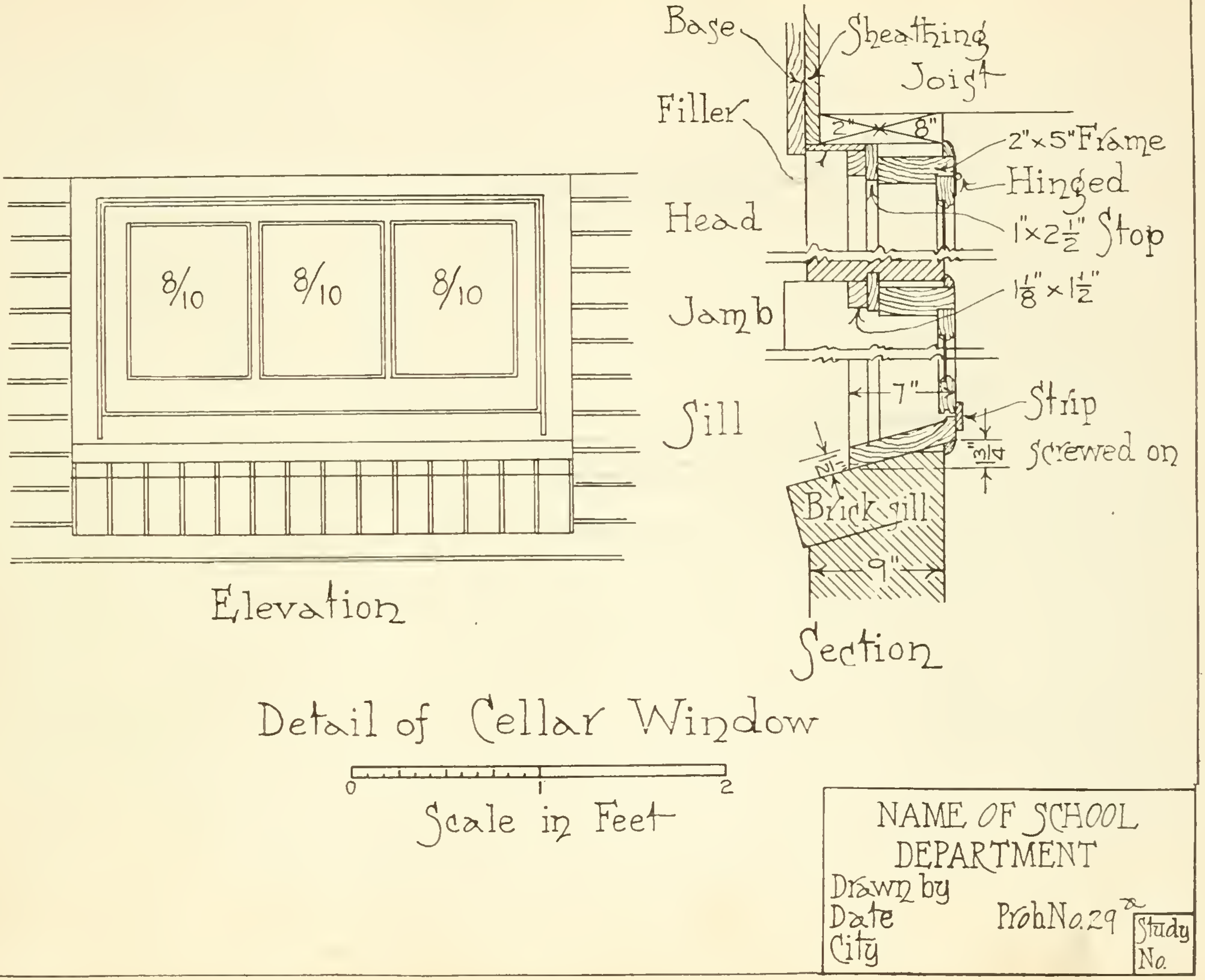
PROBLEM 29. DETAIL OF CELLAR WINDOW

This drawing shows a detail of a cellar sash and frame.

a. Make a drawing similar to the one shown but for a three-light sash, each light to be 10″×12″. Use $1\frac{1}{2}''=1$ ft. scale.

b. Make a drawing for a two-light cellar sash, each light to be 14″×16″.

c. Make a drawing showing a cheaper construction with merely a rebate in the frame to receive the screen.



Detail of Cellar Window

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 29ª
Study No.

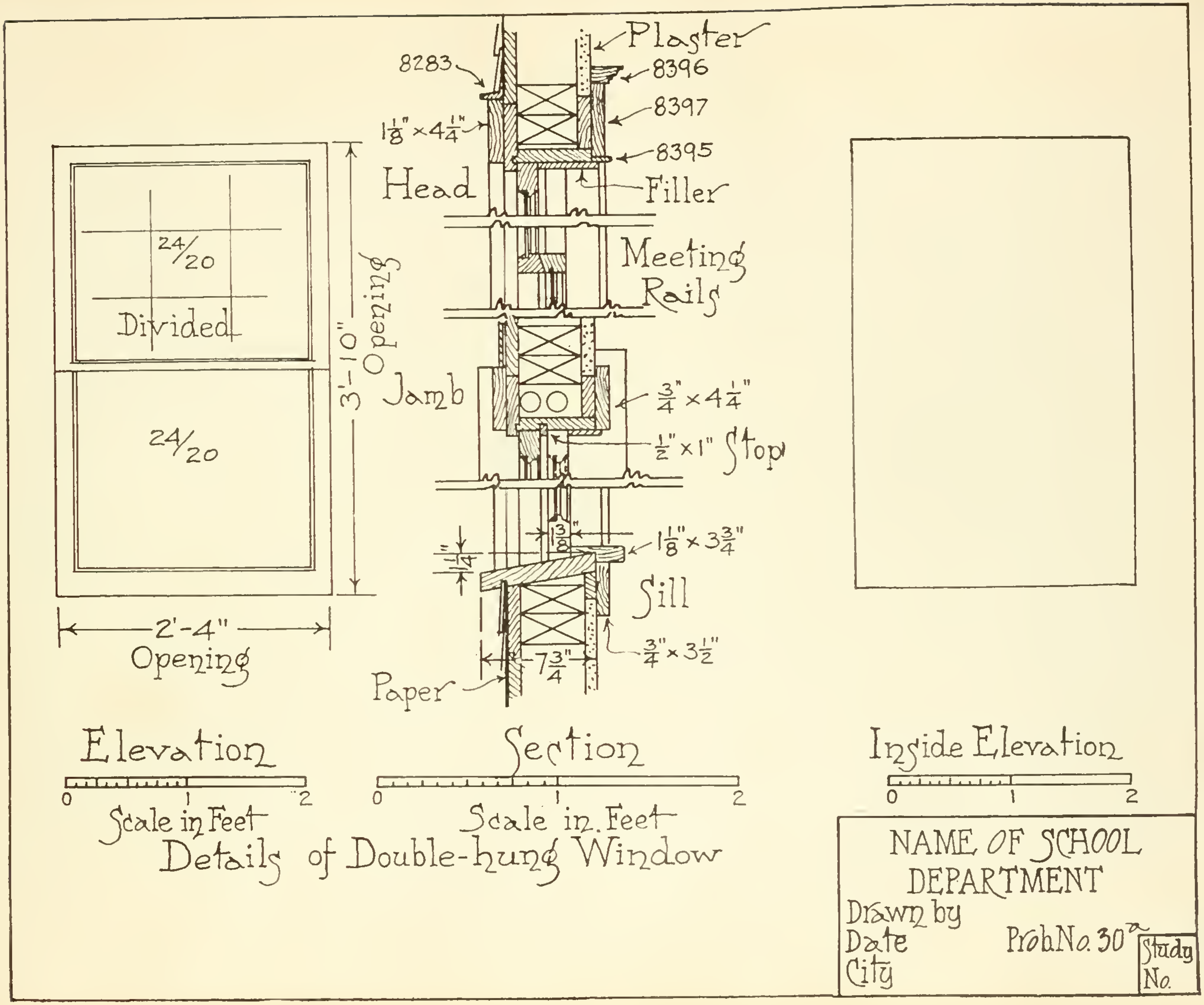
PROBLEM 30. DETAILS FOR DOUBLE-HUNG WINDOW

This drawing shows a detail for double-hung check rail window for a frame house.

a. Make a drawing similar to the one shown but complete the outside and inside elevations, showing the exterior and interior trim. Show the muntins in detail in the upper sash. The numbers shown on the drawing refer to the corresponding mouldings in the Official Moulding Book. Use $1\frac{1}{2}'' = 1$ ft. scale for the sections and $1'' = 1$ ft. or the elevations.

b. Make a similar drawing but show the glass size $26'' \times 26''$.

c. Make a detail drawing of casement windows with hinged sash to swing outward. Divide the glass into diamond shapes and use two sash $26'' \times 26''$ glass size. These sashes should be rebated at the meeting to make them weather-proof.


Details of Double-hung Window

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PROBLEMS: PART IV

BUILDING DETAILS

TITLES

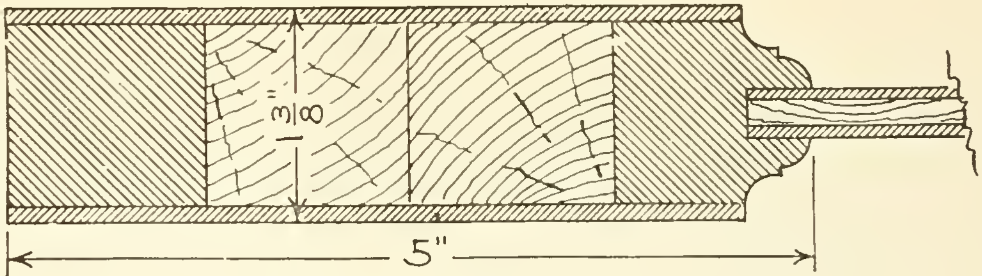
Problem 31. Interior Door and Trim.
Problem 32. Porch Details.
Problem 33. Stairs.
Problem 34. Entrance Porch.
Problem 35. Garden Arbor.
Problem 36. Built-in Book Shelves.
Problem 37. Built-in China Closet.
Problem 38. Kitchen Cupboard and Work-table.
Problem 39. Sleeping Balcony and Terrace.
Problem 40. A Sketch Plan for a Frame House.

PROBLEM 31. INTERIOR DOOR AND TRIM

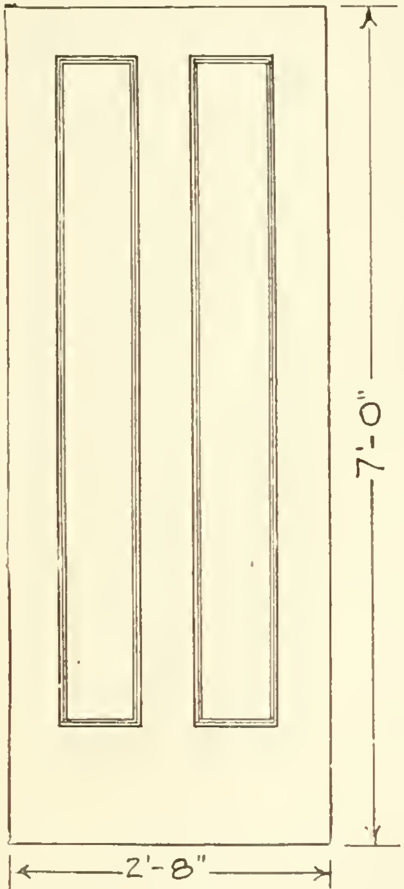
This shows a two-panel door and details of the trim.

a. Make a drawing similar to this and complete it by drawing a section detail of the jamb. The jamb is the side board of the frame to which the hinges are fastened. Also show the trim in place about the elevation. Use full-size scale for the section through the stile, 3″ = 1 ft. for the sections and ¾″ = 1 ft. for the elevation.

b. Make a similar drawing but for a five-cross panel door.

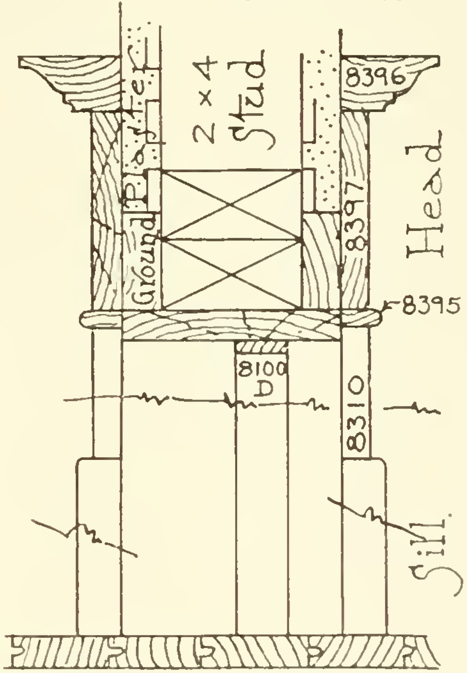


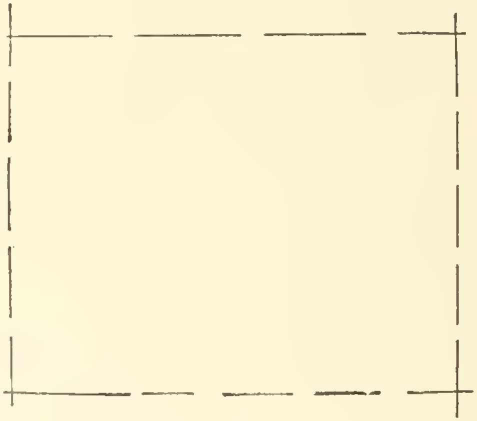
Section thru Stile.



Elevation

0 1 2 3
Scale in Feet





Section thru Jamb

0 1
Scale in Feet
Interior Door and Trim

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 31a
Study No.

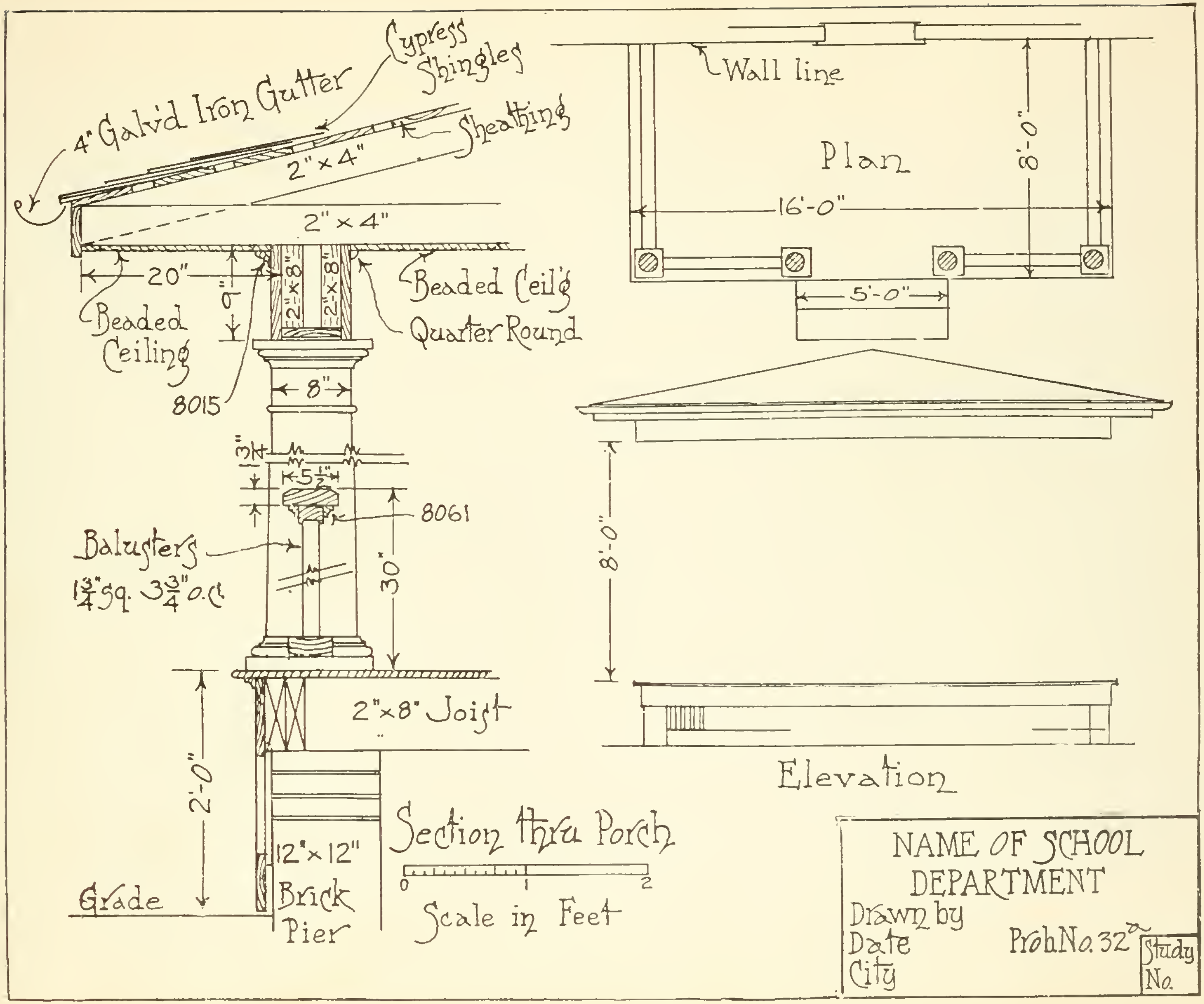
PROBLEM 32. PORCH DETAILS

This drawing shows a section through the cornice and railing for a porch.

a. Make a similar drawing and complete it by filling in the details in the elevation of the porch. Use a scale of 1″ = 1 ft. for the sections and $\frac{1}{4}$″ = 1 ft. for the plan and elevation.

b. Make a similar drawing but show exposed rafter ends and sawn balusters to match in the California bungalow style. Use square built-up posts. Be sure that your work is in good architectural taste.

c. Examine any porch arrangement which you admire and make a drawing of it.


Cypress Shingles
4" Galv'd Iron Gutter
Sheathing
2"×4"
2"×4"
20"
8"
Beaded Ceiling
8015
2"×8"
2"×8"
Beaded Ceil'g
Quarter Round
8"
3"
5½"
8061
30"
Balusters 1¾" sq. 3¾" o.c.
2"×8" Joist
2'-0"
12"×12" Brick Pier
Grade
Section thru Porch
0
1
2
Scale in Feet
Wall line
Plan
8'-0"
16'-0"
5'-0"
8'-0"
Elevation
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob No. 32a
Study No.

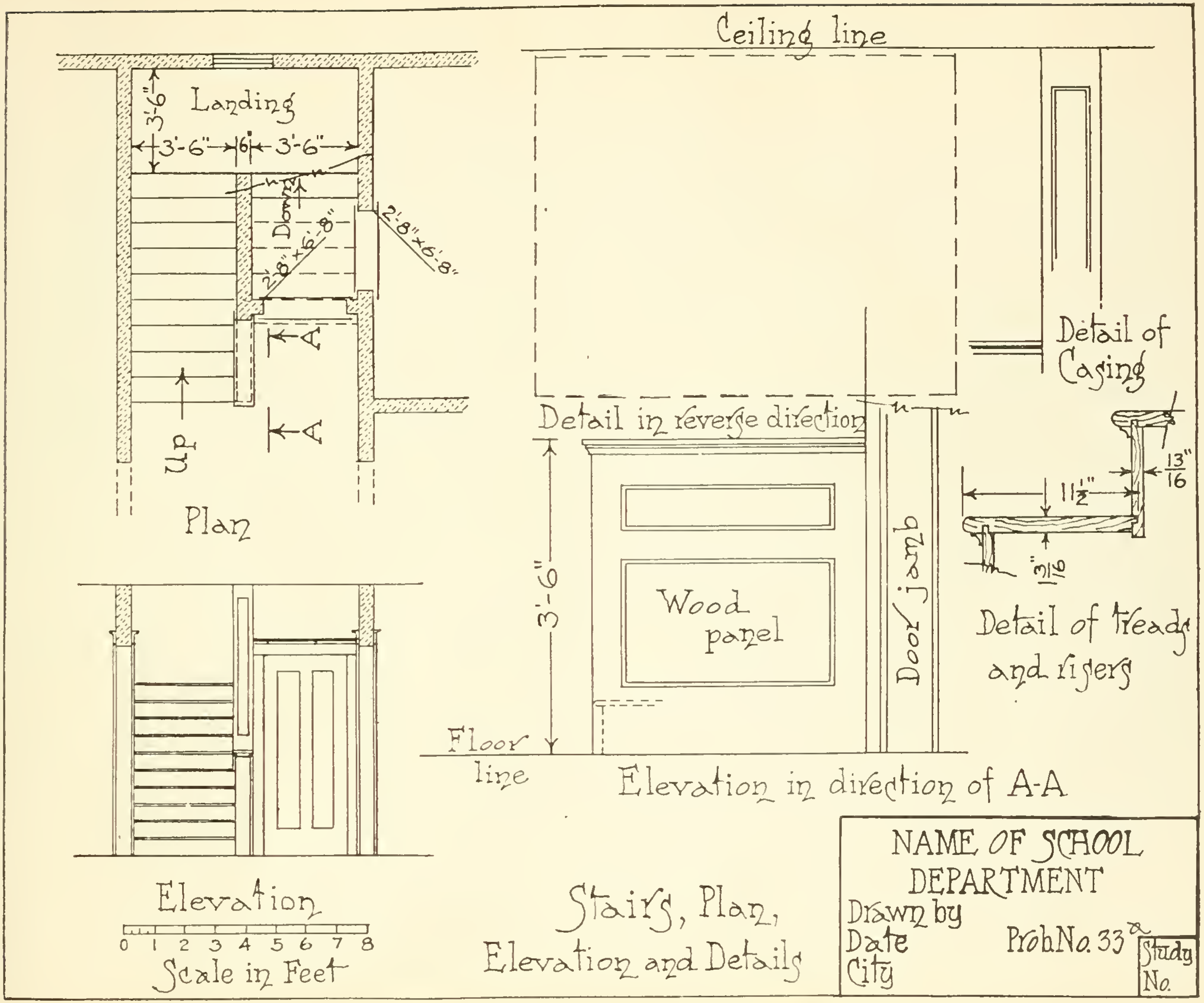
PROBLEM 33. STAIRS

This problem shows plan, elevations and details for a flight of stairs. There is a tendency at the present time to make of the stairs an effective piece of furniture and to remove from them the formal effect so often seen in the older houses.

a. Make a similar drawing and complete it by showing a reverse detail as indicated in the drawing. Use $\frac{1}{4}''$ = 1 ft. for plan and elevation, $\frac{3}{4}''$ = 1 ft. for detail of pedestal and $1\frac{1}{2}''$ = 1 ft. for tread and risers.

b. Measure up a staircase to which you have access and make complete drawings of it. Show plan, elevation and details.

c. Find a picture of a stairs in a catalog or magazine and make the necessary drawings for the builder.


Ceiling line
Landing
3'-6"
3'-6"
6
3'-6"
Down
2'8"×6'-8"
2'8"×6'-8"
A
A
Up
Plan
Detail in reverse direction
3'-6"
Wood panel
Door jamb
Detail of Casing
11½"
13/16"
3/16"
Detail of treads and risers
Floor line
Elevation in direction of A-A
Elevation
0 1 2 3 4 5 6 7 8
Scale in Feet
Stairs, Plan, Elevation and Details
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob.No. 33a
Study No.

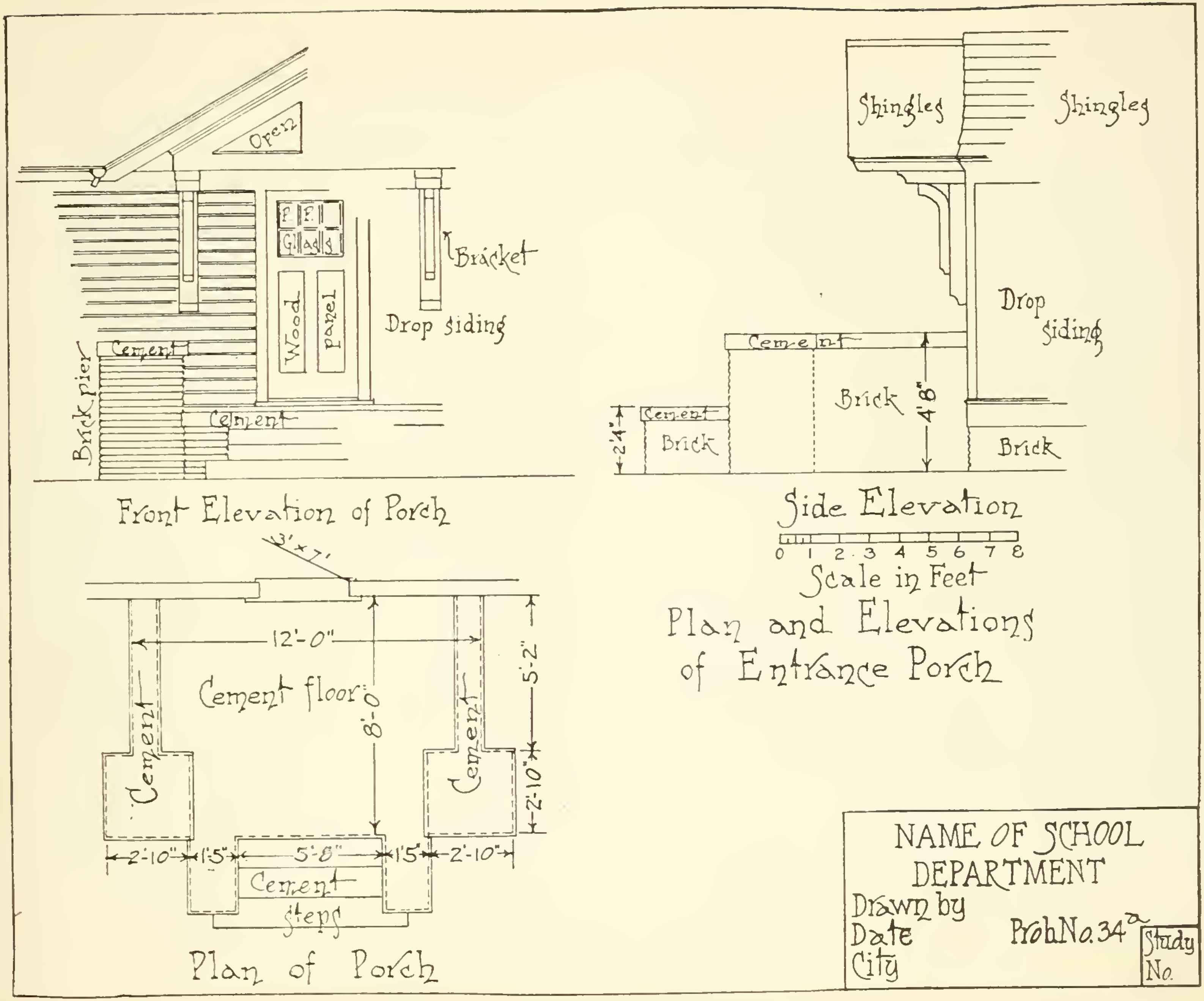
PROBLEM 34. ENTRANCE PORCH

It is becoming common to place the main porch to the side or rear of the house and to provide a mere stoop and hood for the front door entrance.

a. Make the drawing as indicated and complete it by filling in the details. Do not fail to dimension it completely. Use a scale of $\frac{1}{4}'' = 1$ ft.

b. Make a scale detail drawing of the bracket and dimension it fully. Use a scale of $1\frac{1}{2}'' = 1$ ft.

c. Make a scale detail drawing of the entrance hood and dimension it fully. Use $\frac{3}{4}'' = 1$ ft.


Open
F. F. Glass
Wood panel
Bracket
Drop siding
Cement
Brick pier
Cement
Front Elevation of Porch
Shingles
Shingles
Drop siding
Cement
Cement
Brick
Brick
Brick
2'4"
4'8"
Side Elevation
0 1 2 3 4 5 6 7 8
Scale in Feet
Plan and Elevations of Entrance Porch
3'×7'
12'-0"
Cement floor
8'-0
5'-2"
2'-10"
Cement
Cement
2'-10" 1'5" 5'-8" 1'5" 2'-10"
Cement steps
Plan of Porch
NAME OF SCHOOL
DEPARTMENT
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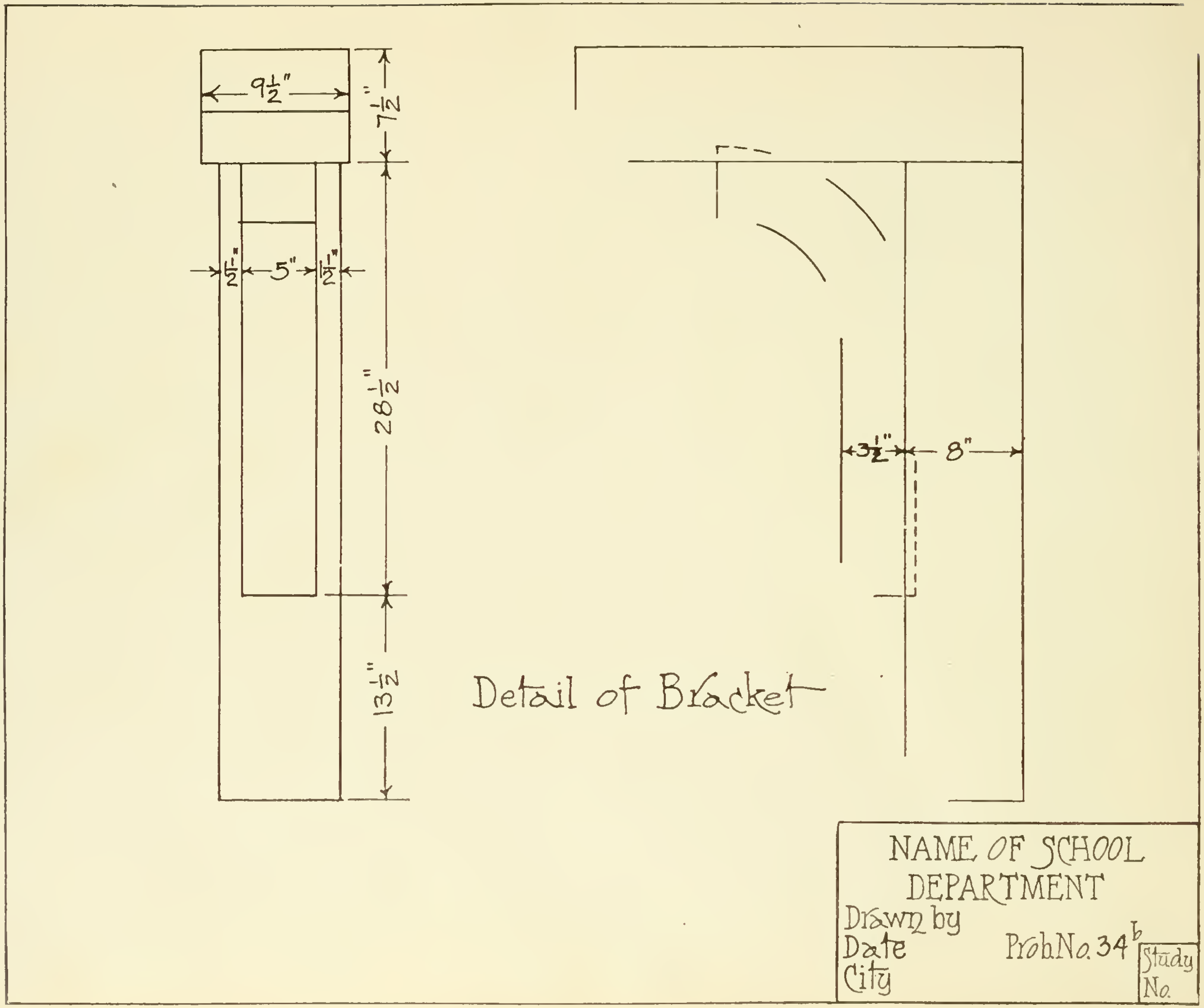
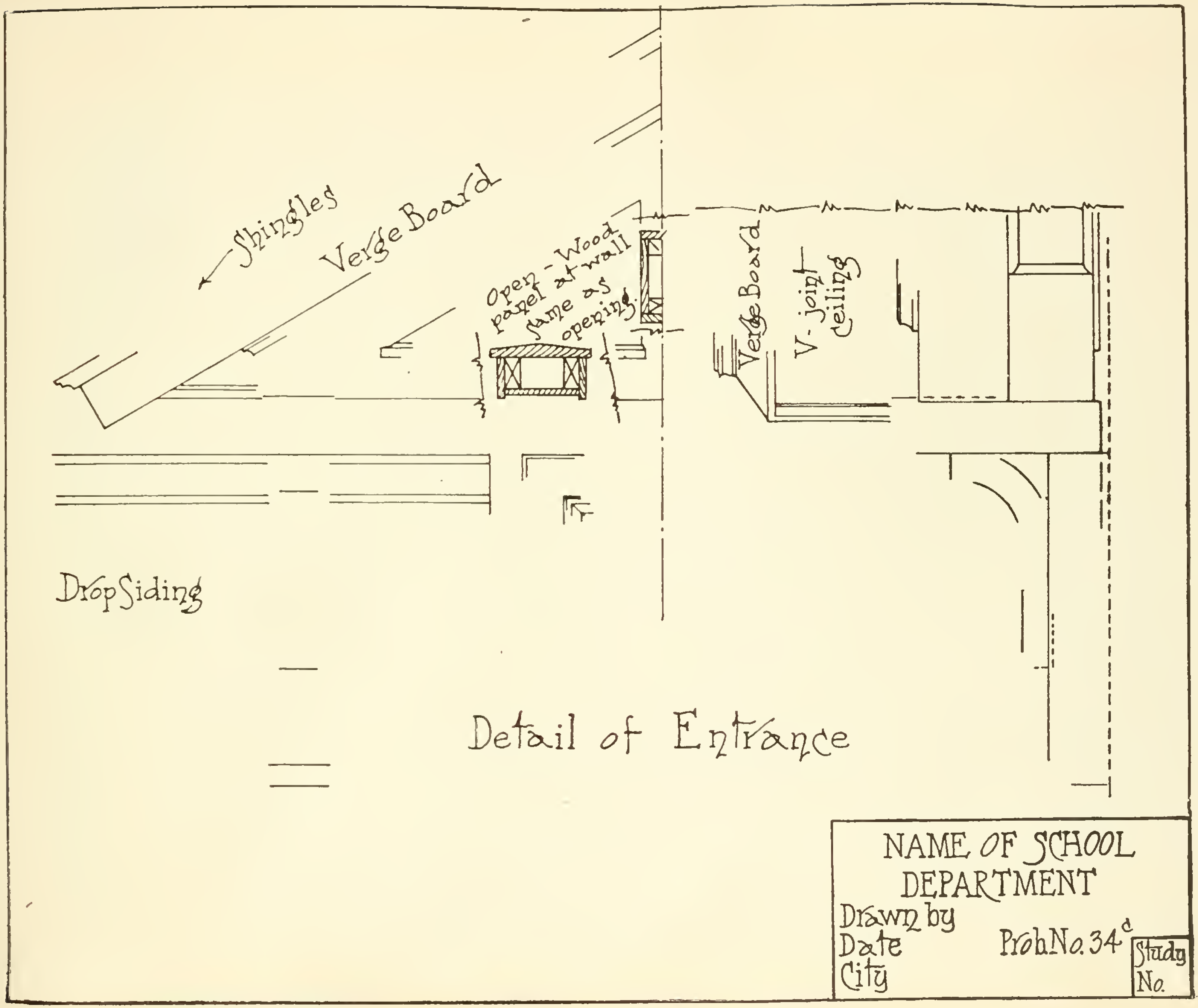
Date
City
Prob No. 34a
Study No.


9½"
7½"
½"
5"
½"
28½"
13½"
3½"
8"
Detail of Bracket
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob.No.34b
Study No.



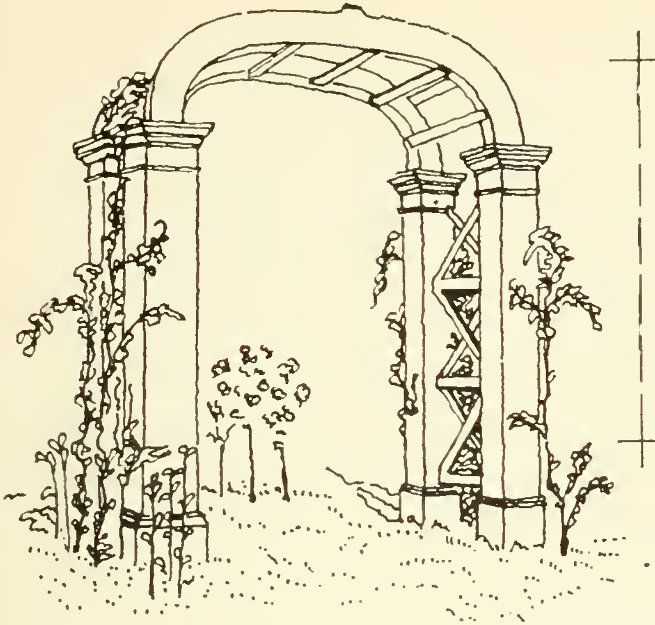
Detail of Entrance

PROBLEM 35. GARDEN ARBOR

An arbor is a delightful piece of furniture for the garden. The sketch in the upper left-hand corner shows how the arbor will appear when it is completed.

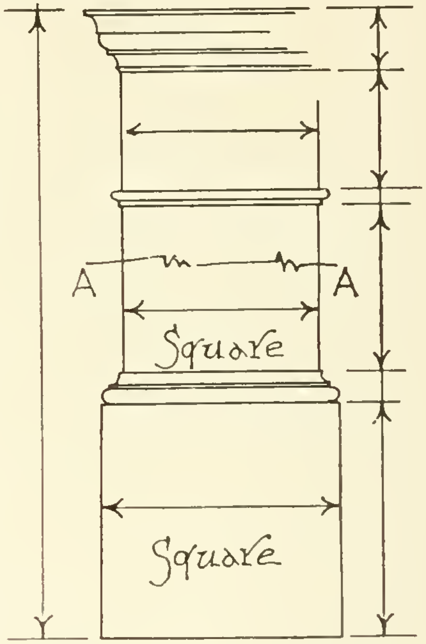
a. Draw the elevation and details complete and dimension them. Choose your own dimensions but use proper regard for correct proportions. Do not copy the sketch. Use $\frac{1}{4}'' = 1$ ft. for the general views, $\frac{1}{2}'' = 1$ ft. for detail of arch and $1\frac{1}{2}'' = 1$ ft. for the posts.

b. Make the drawings for a garden arbor of your own design and completely dimension them.



Detail of Arch

Partial Section at A-A



Elevation of Post

Garden Arbors Elevation and Details

Elevation

Side View

NAME OF SCHOOL
DEPARTMENT
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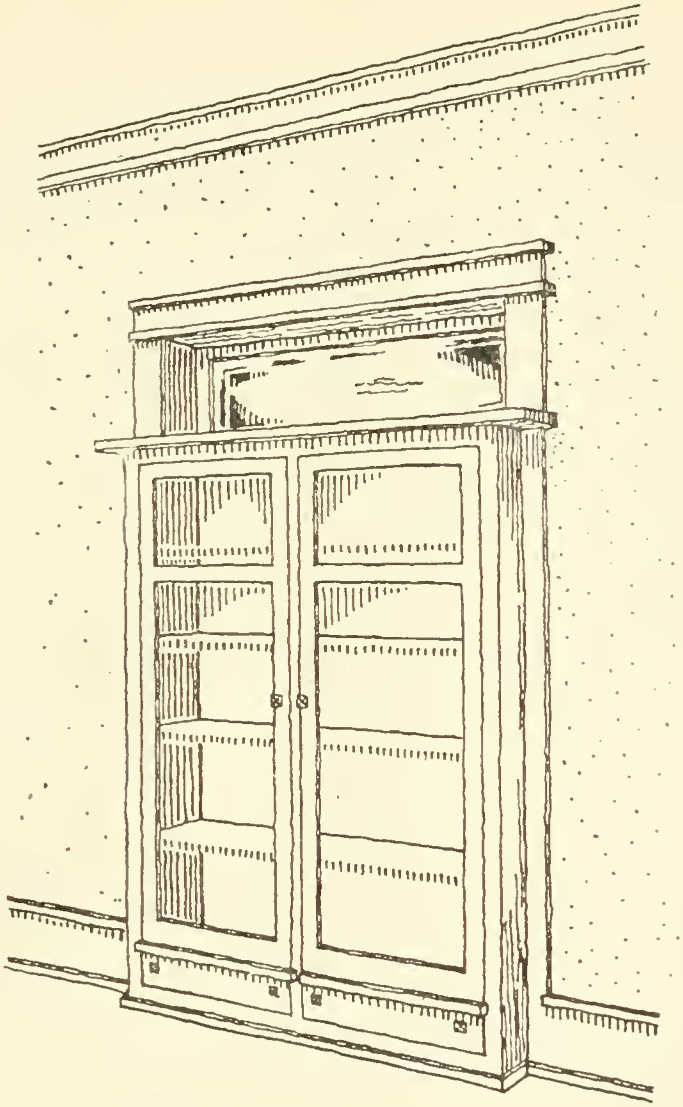
Date
City
Prob. No. 35a
Study No.

PROBLEM 36. BUILT-IN BOOK SHELVES

This problem shows a set of built-in book shelves. Such shelves are frequently set in a suitable niche or corner or under a high window. They require but little space in the room and are in harmony with the general style of the interior trim.

a. Make complete scale details and dimension them. Show the partial sections indicated. Be sure that your drawing indicates workmanlike construction. Do not copy the sketch. Use $\frac{3}{4}''=1$ ft.

b. Book shelves are frequently placed in the pedestals of a colonnade. Show complete detail drawings of such an arrangement.



Built-In Book Shelves

NAME OF SCHOOL
DEPARTMENT
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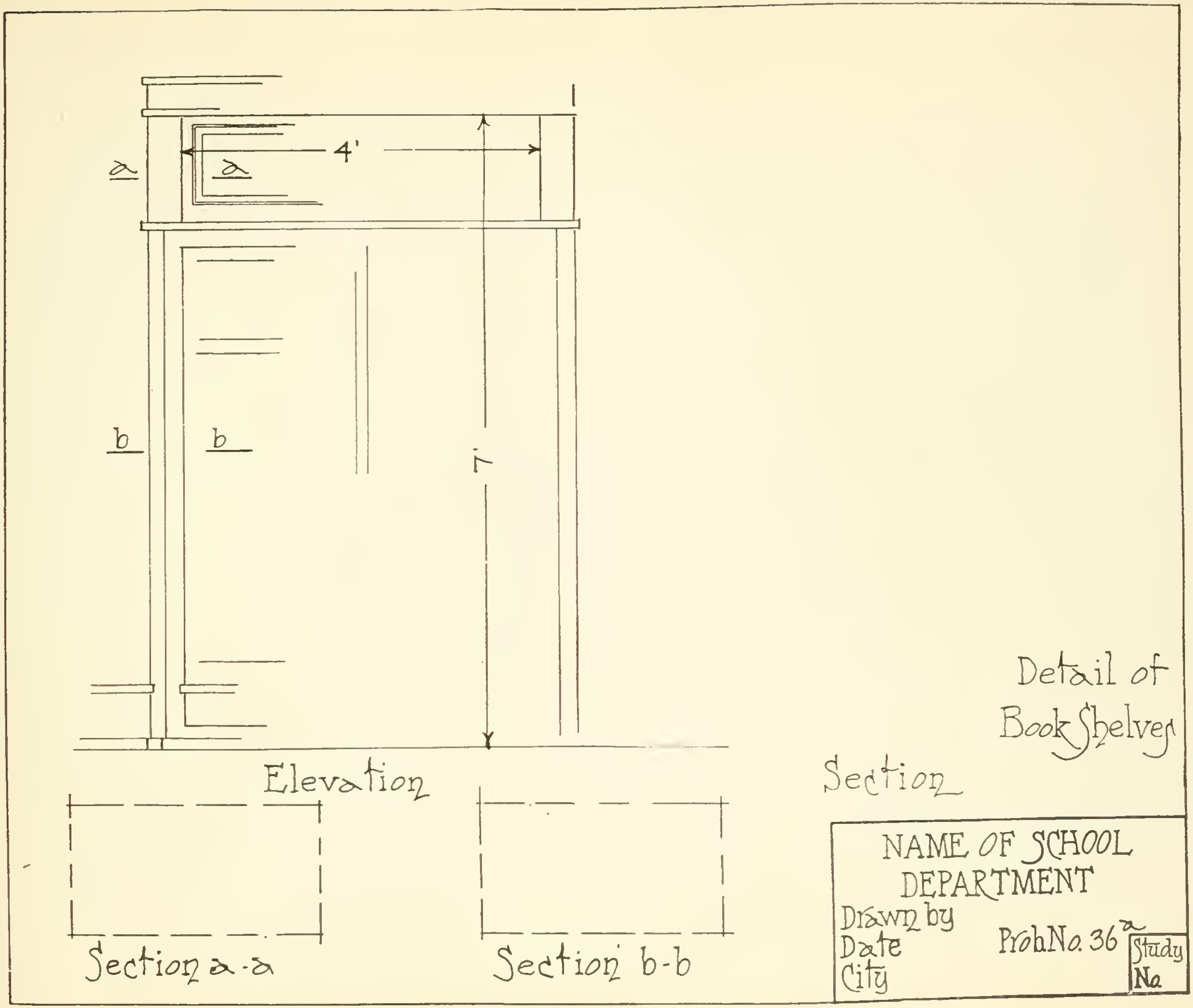

a
a
4'
7'
b
b
Elevation
Section
Detail of
Book Shelves
Section a-a
Section b-b
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob No. 36a
Study
No.

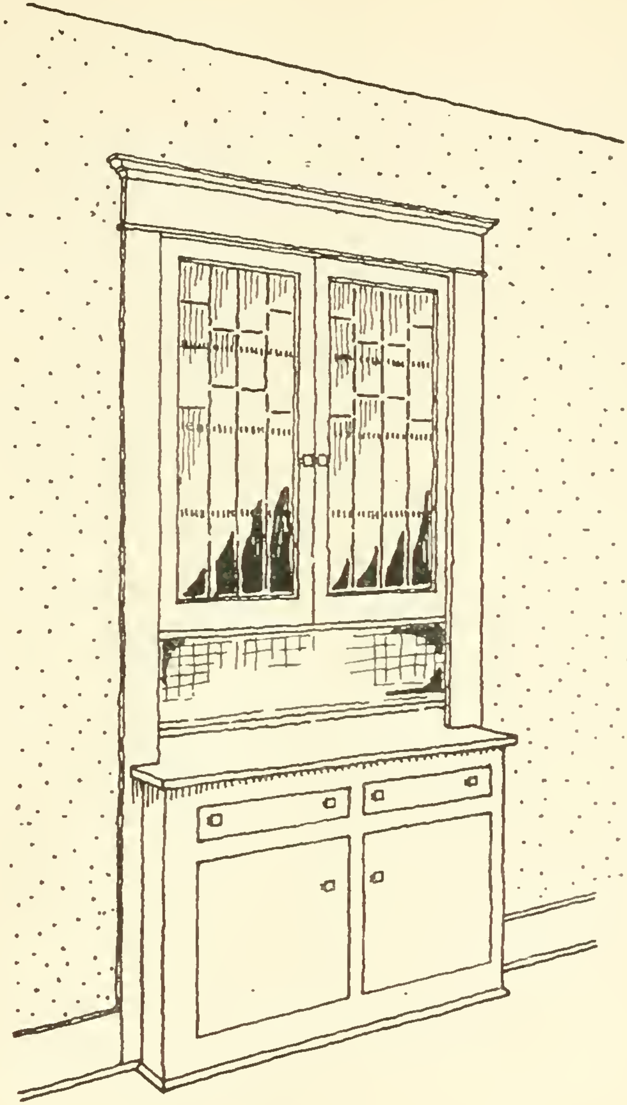
PROBLEM 37. BUILT-IN CHINA CLOSET

This is a suggestion for a built-in china closet. Small drawers for the silverware are beneath the open shelf, while below this are two hinged doors opening to shelves where the heavier pieces of table service are kept. The upper shelves are adjustable by means of shelf pins fitting into small holes at the sides. Many other arrangements of this convenient piece of built-in dining-room furniture will suggest themselves.

a. Make complete details and sections and dimension the drawing fully. Use $\frac{3}{4}'' = 1$ ft. scale.

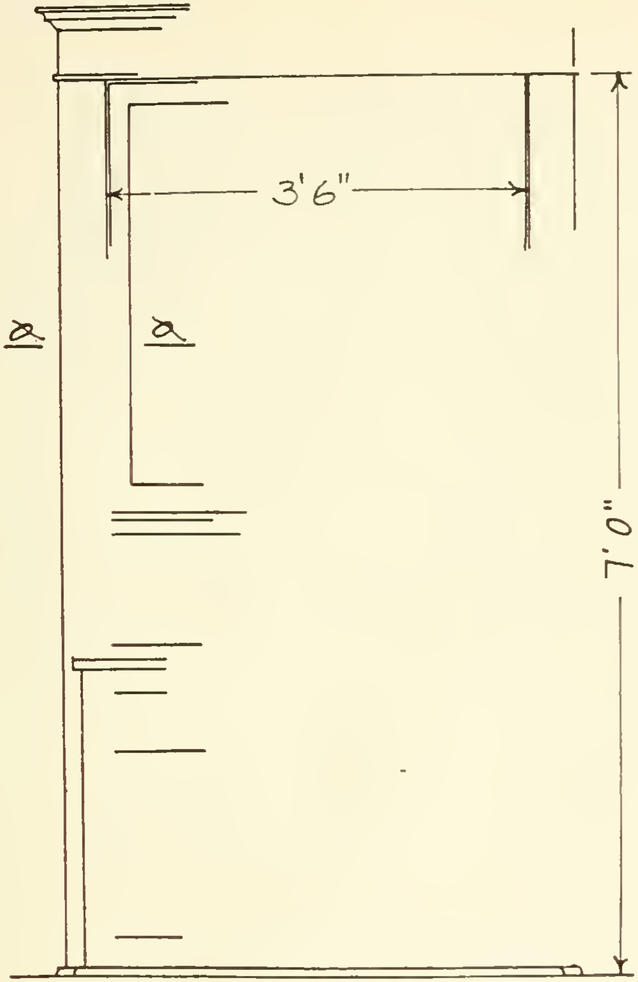
b. Measure a built-in china closet to which you may have access and make complete detail drawings of it.

c. Design a china closet or buffet according to your own ideas and make complete detail drawings of it.



Built-In
China Closet
with leaded
glass doors and
polished plate
mirror

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 37
Study
No.



Section a-a

Elevation

Section

Detail of China Closet

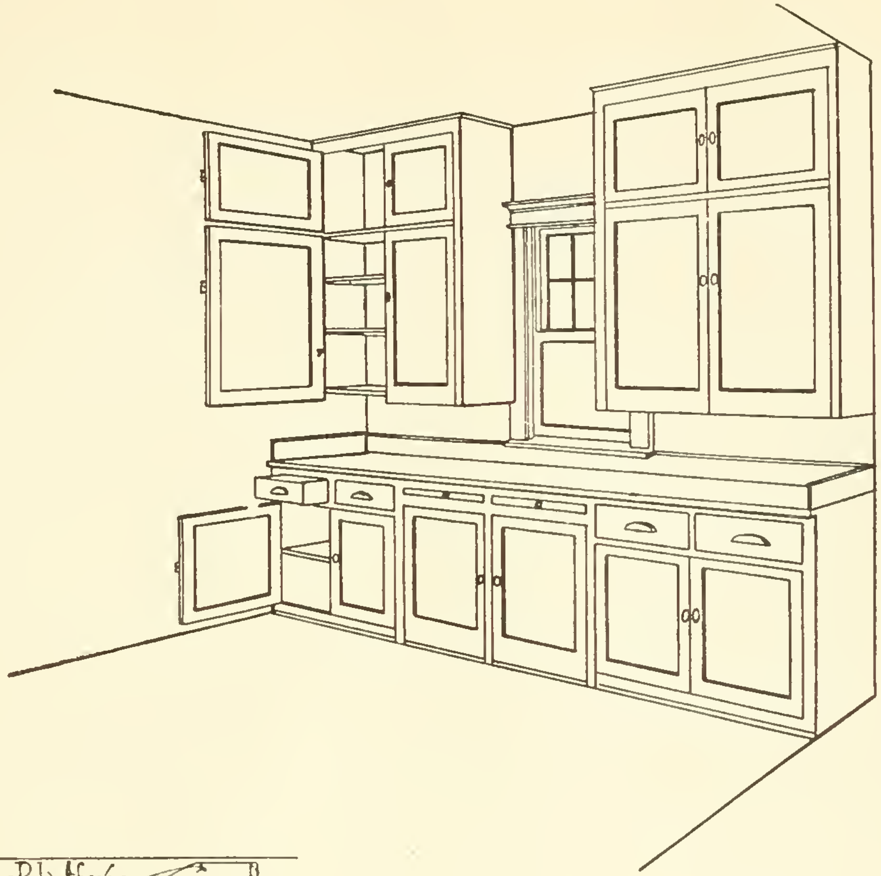
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 37^a
Study No.

PROBLEM 38. KITCHEN CUPBOARD AND WORK-TABLE

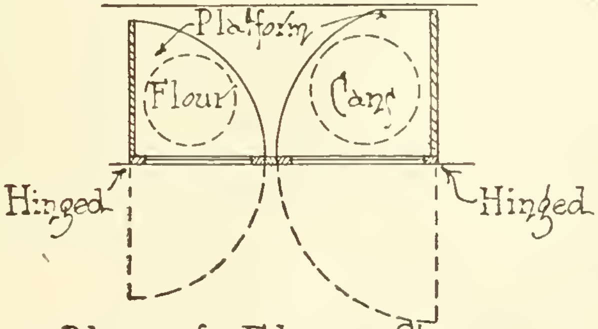
Convenient kitchen arrangements are appreciated by the housewife. This is a suggestion for a kitchen cupboard and work-table.

a. Make complete detail drawings and dimension them fully. Use $\frac{1}{2}''=1$ ft. scale.

b. Design a similar work-table but incorporate the sink and drain-board into the arrangement. Do not neglect to put a small shallow knife drawer under the drain-board. It is not considered good to put shelves under the sink or to enclose this space in any way.



Perspective View of Kitchen Cupboard and Work-table



Plan of Flour Storage Compartment

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DEPARTMENT
Drawn by
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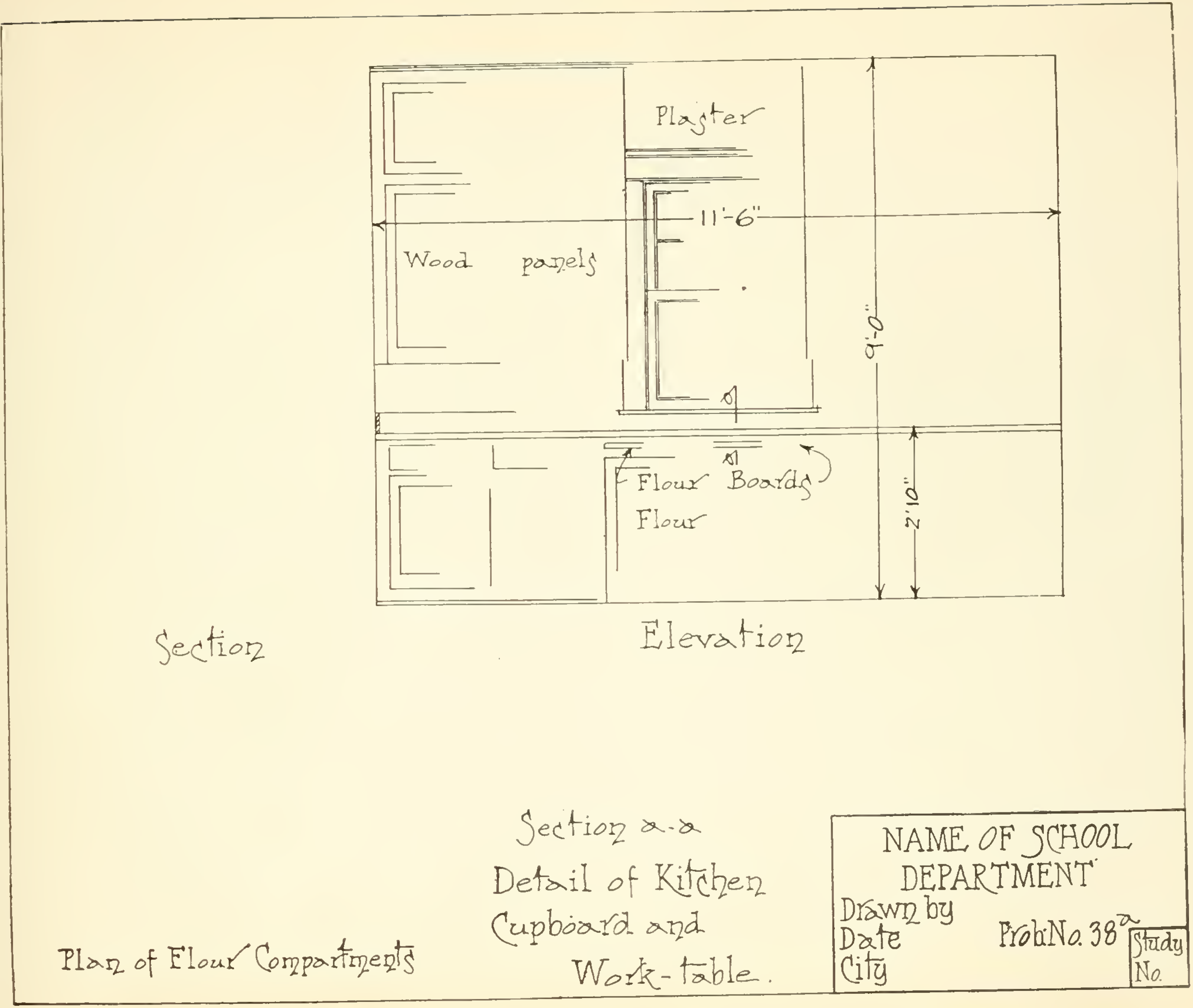
City
Prob No. 38
Study No.

ASTOR, LENOX
TILDEN FOUNDATIONS


Plaster
11'-6"
Wood panels
9'-0"
a
a
Flour Boards
Flour
2'10"
Section
Elevation
Section a-a
Detail of Kitchen Cupboard and Work-table.
Plan of Flour Compartments
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 38a
Study No.

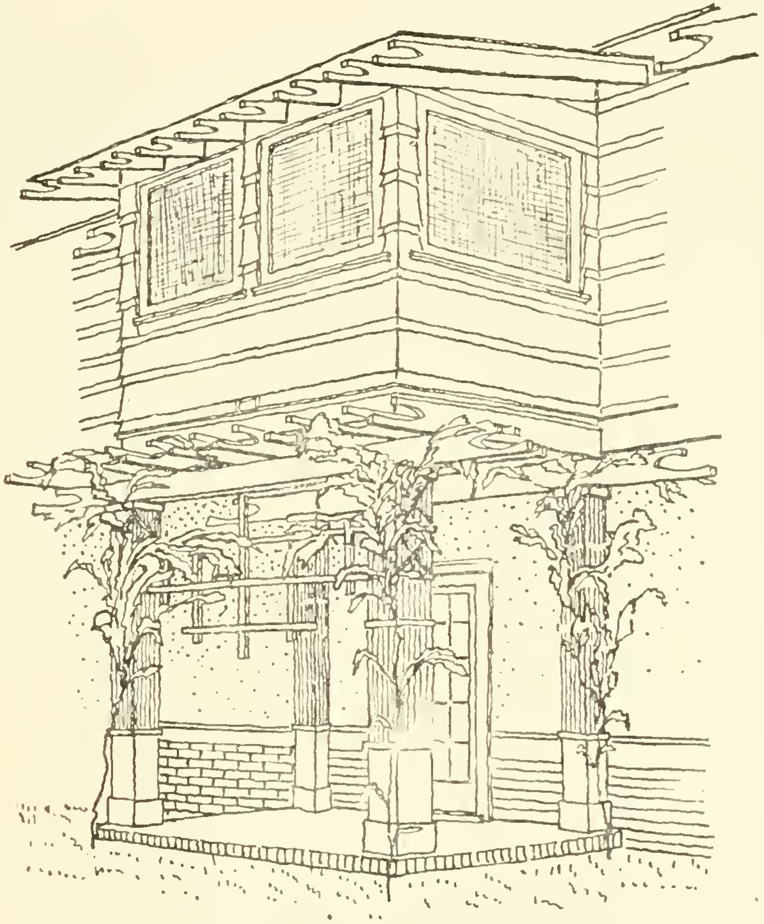
PROBLEM 39. SLEEPING BALCONY AND TERRACE

A sleeping porch or balcony is a desirable addition to any home. It should, however, harmonize with the architecture of the house and not appear to be tacked on as an afterthought. The pergola and terrace idea will enable a commodious balcony to be built and the posts will provide ample support.

a. Show a front elevation and side view complete. Use a scale of $\frac{1}{4}'' = 1$ ft.

b. Show a plan of balcony, detail of exposed rafter ends and a detail of the post. A graceful but not very durable post may be made of eight $2'' \times 2''$ latticed together. Use a scale of $\frac{1}{4}'' = 1$ ft. for the plan and suitable scales for the details.

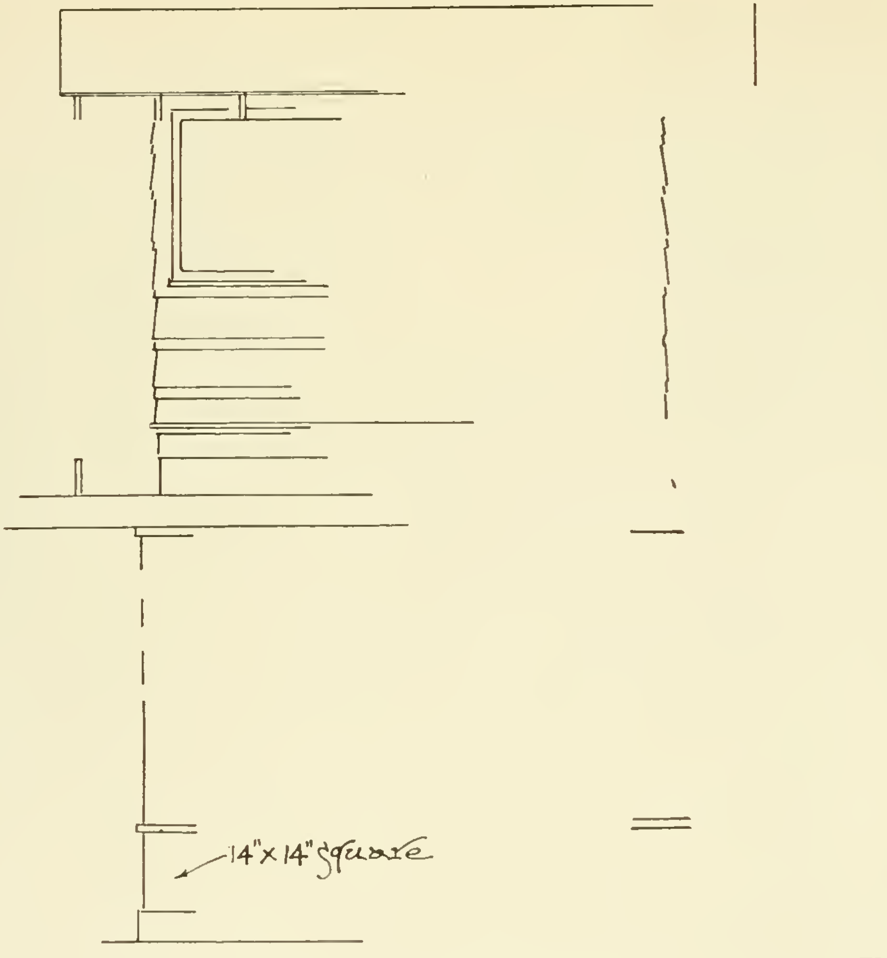
c. Make complete drawings of a sleeping porch or balcony of your own design.



Sleeping Balcony
and Terrace
with Pergola Effect.

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date Prob. No. 39
City

Study
No.

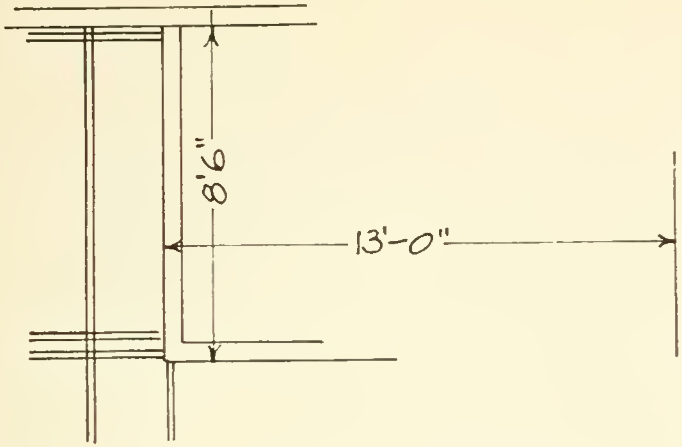


Front Elevation

Side View

Detail of Sleeping Balcony

NAME OF SCHOOL
DEPARTMENT
Drawn by
Date Prob No. 39a
City
Study No.



Plan of Balcony

Detail of Post

Detail of Rafter Ends

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DEPARTMENT
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City
Prob. No. 39^b
Study No.

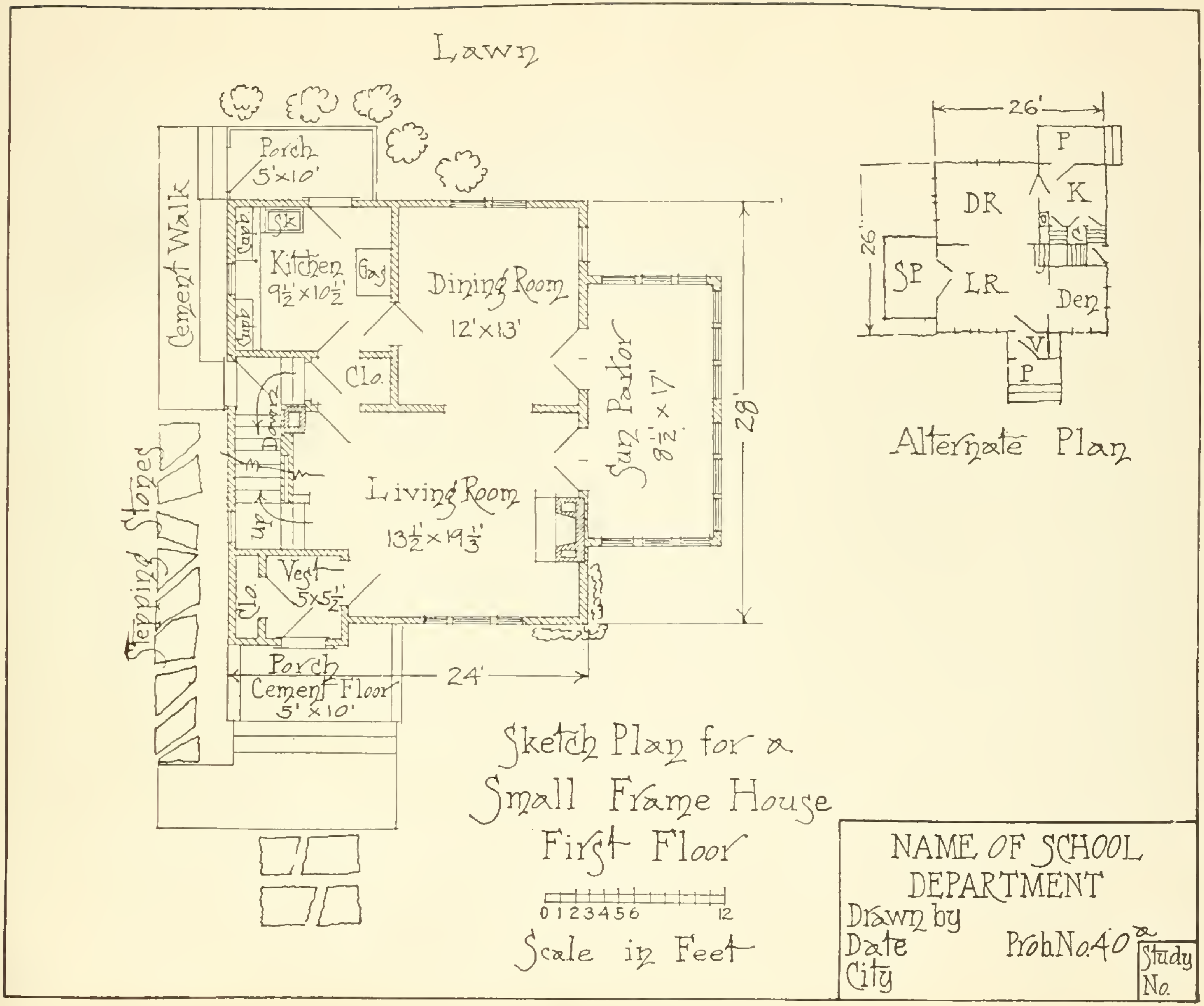
PROBLEM 40. SKETCH PLAN FOR A SMALL FRAME HOUSE

One of the most interesting problems is the planning of small dwelling houses. Preliminary sketch plans are usually made for the owner and after he is satisfied with the arrangement, the working drawings are produced. It is in connection with this work that the skill and knowledge of the architect are brought into play.

a. Make a sketch plan like the one shown. Use a scale of $\frac{1}{8}'' = 1$ ft.

b. Work out a suitable plan for the second floor. Provide for a bath-room and three chambers with suitable closets. Indicate the dimensions of the rooms. Use $\frac{1}{8}'' = 1$ ft. scale.

c. Make first and second floor plans on the alternate schemes shown in the upper right-hand corner of the accompanying drawing. Be sure to work out every detail in a satisfactory manner. Be especially careful with the stair arrangement and do not forget the chimney. Use a scale of $\frac{1}{8}'' = 1$ ft.


Lawn
Porch 5'×10'
Cement Walk
Sk
Cupb.
Kitchen 9½'×10½'
Gas
Cupb.
Dining Room 12'×13'
Clo.
Down
Up
Living Room 13½'×19⅓'
Sun Parlor 8½'×17'
28'
Stepping Stones
Clo.
Vest 5×5½'
Porch Cement Floor 5'×10'
24'
26'
P
DR
K
C
SP
LR
Den
26'
V
P
Alternate Plan
Sketch Plan for a Small Frame House First Floor
0 1 2 3 4 5 6 12
Scale in Feet
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
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Prob.No.40a
Study No.

PROBLEMS: PART V

CONSTRUCTION IN BRICK, TILE AND TERRA COTTA

TITLES

Problem 41. Detail of Window in Hollow Tile Wall.
Problem 42. Various Brick Bonds and Patterns.
Problem 43. Porch for Hollow Tile House.
Problem 44. Facade of a Plastered Tile House.
Problem 45. Study of Gable and Bay Window in Brick.
Problem 46. Entrance Gate.
Problem 47. Design for a Brick Fireplace.
Problem 48. Entrance in Brick and Terra Cotta.
Problem 49. A Brick Garden Wall and Niche.
Problem 50. A Small Garage in Brick.

PROBLEM 41. DETAIL OF WINDOW IN HOLLOW TILE WALL

The dead monotonous wall surface of a stuccoed or plastered house has been one of the few objections to this type of construction. To relieve this monotony nothing is more effective than brick trim. The arrangement of the brick trim about the double window in this problem is particularly pleasing.

The wall of this house is built of hollow tile blocks which measure 5″×8″×12″. To fill out the corners and other irregular places a half tile which measures 4″×5″×12″ is provided. The brick, which measures about $2\frac{1}{4}''\times 4''\times 8''$, may also be built into such a wall without difficulty.

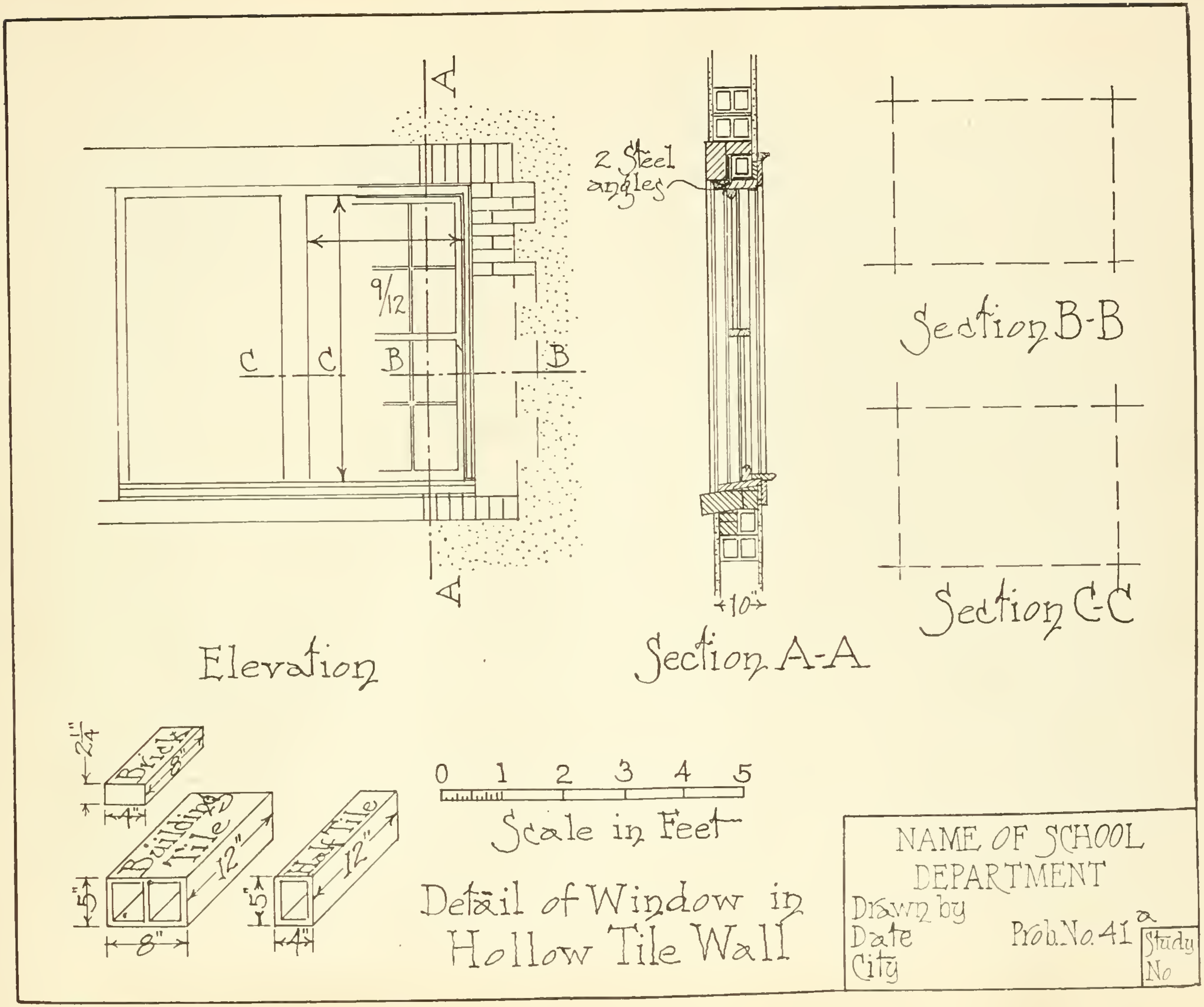
The window frame must necessarily be of wood, although in the more expensive houses pressed steel window frames are sometimes used. The head and sill sections are shown to a small scale in the drawing. The jamb section must provide sufficient room for the window weights and there should be a thin partition between the weight pockets to prevent the weights from interfering with each other.

The center bar between the two windows, called the mullion, is also of wood. This must also provide sufficient space for the window weights. In order to reduce the space required in the weight pockets, lead weights are sometimes used.

a. Complete the drawing shown here showing a section, B–B, through the jamb and another, C–C, through the mullion, Dimension your drawing completely. Use a scale of $\frac{1}{2}''=1$ ft.

b. Make complete large scale detail sections through the head, jamb, sill and mullion. Indicate the size of each piece used and dimension your drawing fully. Choose your own scale.

c. Make a drawing similar to the one shown but provide a low relieving arch of brick over the windows instead of the flat lintel shown here. Dimension your drawing fully.


A
A
2 Steel angles
9/12
C
C
B
B
Elevation
10"
Section A-A
Section B-B
Section C-C
2¼"
Brick
8"
4"
Building Tile
12"
5"
8"
Half Tile
12"
5"
4"
0 1 2 3 4 5
Scale in Feet
Detail of Window in Hollow Tile Wall
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 41a
Study No

PROBLEM 42. VARIOUS BONDS AND BRICK PATTERNS

Most of the attractiveness and life of a brick wall surface depends upon the pattern of the brick-work. Proper bonding of the brick is also necessary for strength.

Bricks which are laid lengthwise to the wall are called stretchers and those which are laid across the width of the wall are called headers. The arrangement of stretchers and headers which ties a brick wall into an integral whole is called the bond. The pattern is the symmetrical arrangement which results and it may be accentuated by using different colors and textures of brick in various positions in the wall.

In laying out patterns it is necessary to take into account the thickness of the mortar joint as well as the dimensions of the brick. The average dimensions of a brick are $2\frac{1}{4}'' \times 4'' \times 8''$. Mortar joints may be of any desired thickness from $\frac{1}{4}''$ to $1\frac{1}{4}''$. Thus the thickness of a brick and one mortar joint may vary from $2\frac{1}{2}''$ to $3\frac{1}{2}''$. The length of a stretcher, header and two joints may vary from $12\frac{1}{2}''$ to $14''$. It will be noticed from the first diagram in the accompanying drawing that the pattern is formed by shifting the vertical joints a quarter of a brick to the right or left. In laying out any pattern it is convenient to make a diagram by drawing a series of horizontal lines a distance apart to scale which will represent the thickness of a brick and a mortar joint and to cross these with a similar series of vertical lines at a distance apart to represent one-quarter of the length of a brick Using these lines for the bottom and right-hand edges of the brick any pattern or bond may be conveniently and easily laid out to scale in the manner indicated in the diagram.

The second diagram represents the common or American bond. This consists of a series of stretcher courses, usually five or seven, which break joints with each other followed by a header course every sixth or eighth course.

The third diagram represents English bond, which consists of alternate header and stretcher courses, with the vertical joints between the stretcher courses in line.

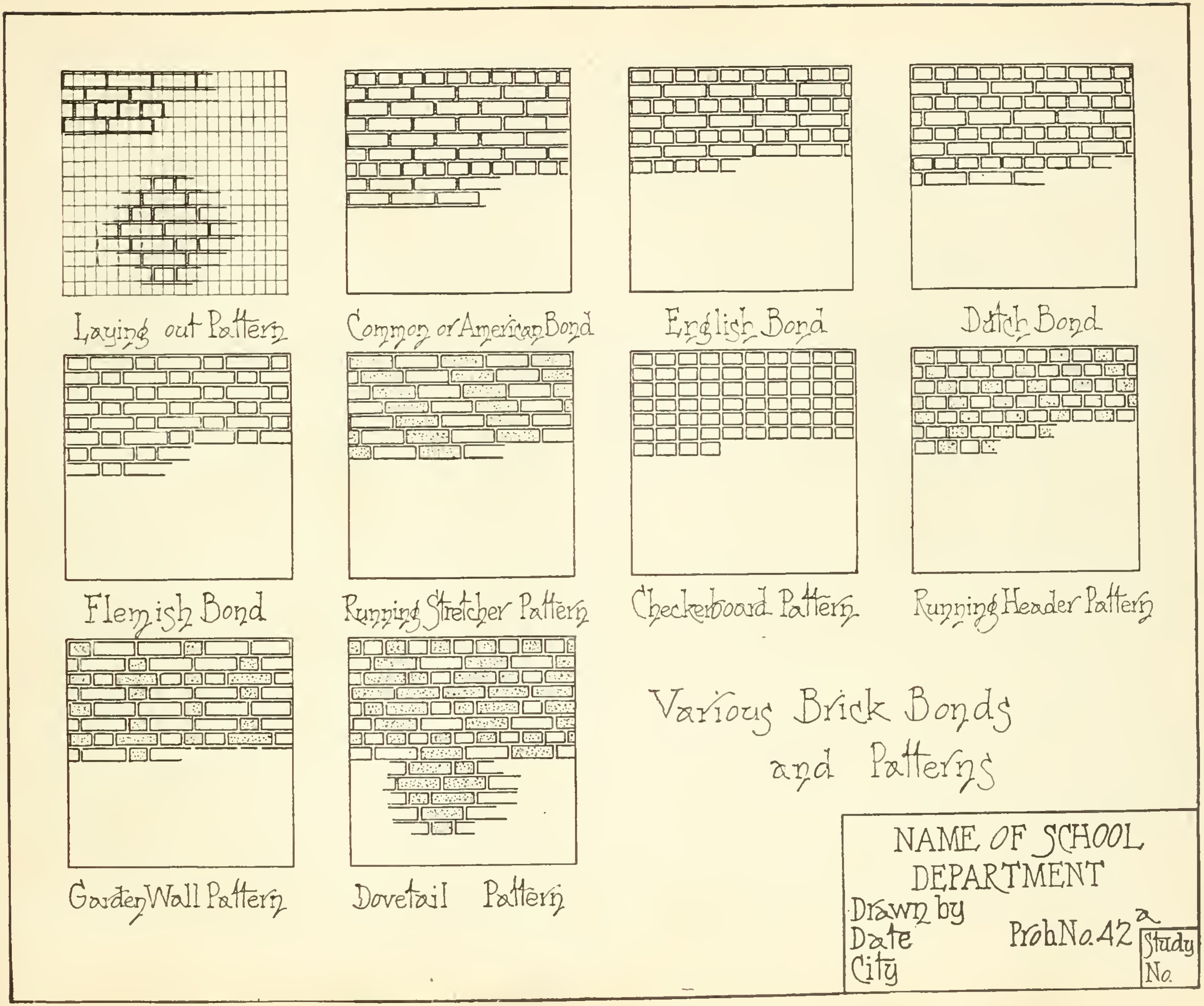
The Dutch bond shown in the fourth diagram is similar to the English bond, except that the vertical joints in the stretcher courses break with each other alternately.

The Flemish bond consists of alternating stretchers and headers in course which break joints with a similar following course.

The various other patterns which follow in the drawing are simply the result of various arrangements of these four fundamental bonds and the diagrams are self-explanatory. For further information about brick bonds and patterns the reader is referred to a pamphlet issued by The Hydraulic Press Brick Company of St. Louis entitled *Bonds and Mortars in the Wall of Brick*.

a. Complete the drawing which accompanies. Use a scale of $\frac{1}{2}'' = 1$ ft. The best way to proceed with this work is to make a diagram to scale similar to the first diagram accompanying on a separate piece of paper and slip this under thin paper or tracing cloth to complete your drawing.

b. Make another series of patterns other than those shown here. Information for your work may be obtained from the pamphlet mentioned above or by copying the patterns from the walls of erected buildings with which you may be familiar. You may even be able to think of some original patterns of your own.



Various Brick Bonds and Patterns

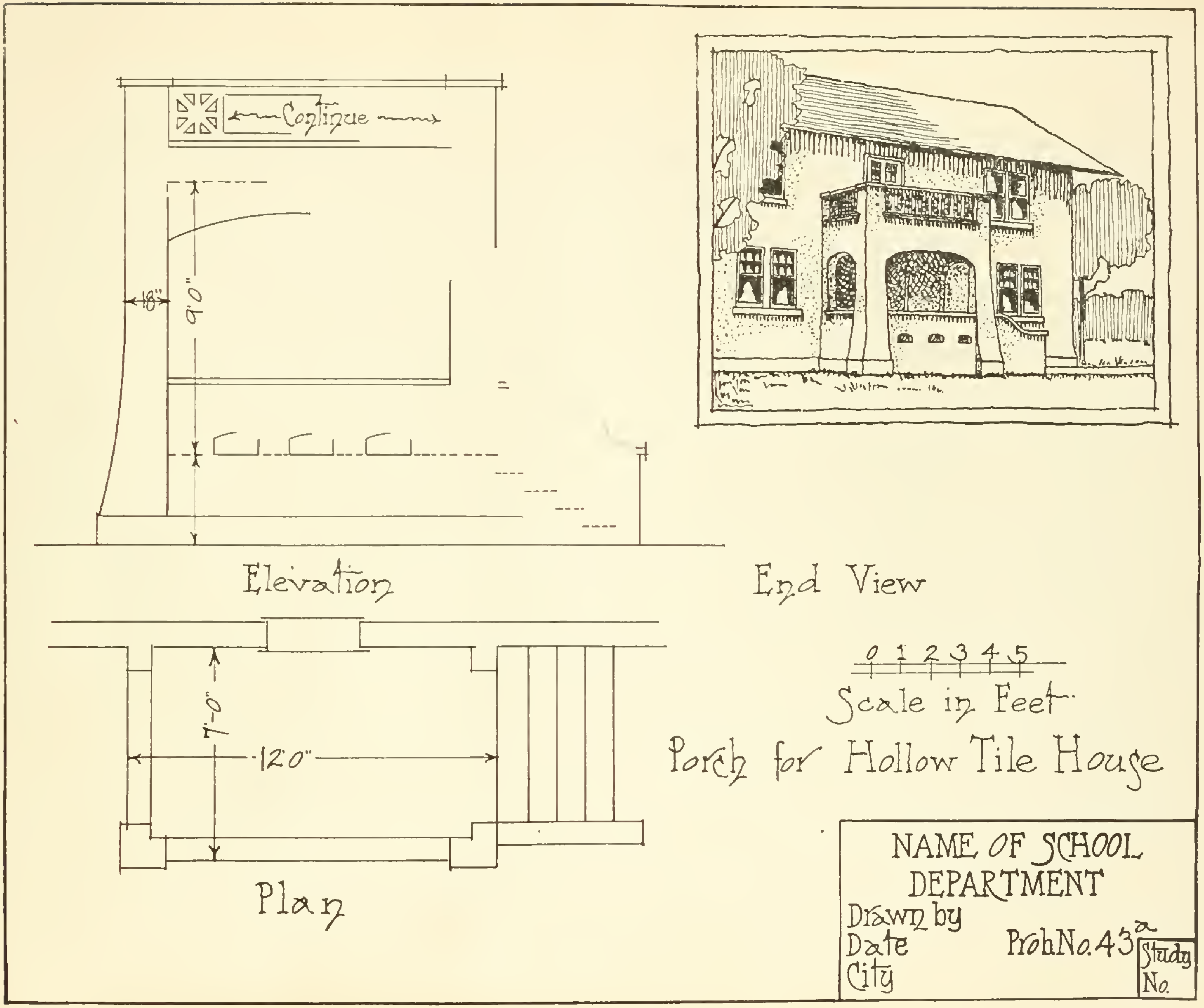
PROBLEM 43. PORCH FOR HOLLOW TILE HOUSE

The advantage of brick and tile products as building materials are so numerous that it is scarcely possible to mention them all here. The one advantage which overshadows all others is that the material is permanent and not subject to decay nor to destruction by fire. When we build with brick or tile we build but once and we should, therefore, build well. We cannot take too much pains to make our houses attractive as well as useful.

The porch shown in the upper right-hand corner of the accompanying drawing illustrates a pleasing arrangement to set off an otherwise extremely plain house.

a. Complete the straight line drawing as suggested. Make a plan, elevation and end view and dimension each fully. Use a scale of $\frac{1}{4}''=1$ ft. Do not try to copy the sketch.

b. Make a drawing of some porch that you have seen on a tile house. Choose your own dimensions, but be careful that the proportions are right.



Porch for Hollow Tile House

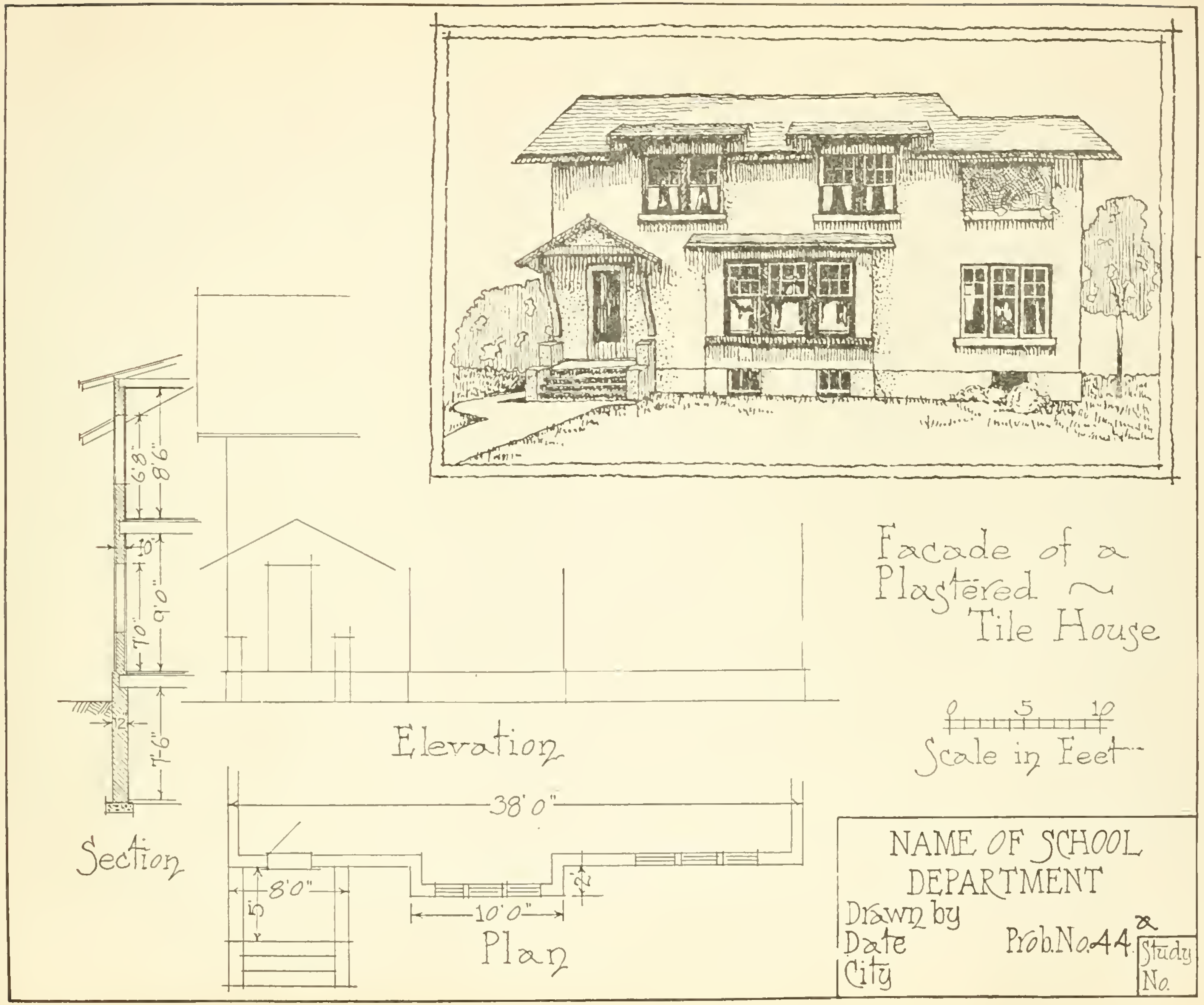
PROBLEM 44. FACADE OF A PLASTERED TILE HOUSE

Plastered tile is a material which should be handled in as simple a manner as possible. It should depend for its attractiveness upon form and proportion rather than embellishment. The accompanying drawing shows the front elevation of a simple but charming house in hollow tile.

a. Complete the straight-line drawing as suggested. Make a section, elevation and part plan. Dimension your drawing as fully as possible. Use a scale of $\frac{1}{8}'' = 1$ ft.

b. Make a similar drawing of any house with which you are familiar.

c. Make a drawing of the facade of a tile house according to your own ideas.



Facade of a Plastered ~ Tile House

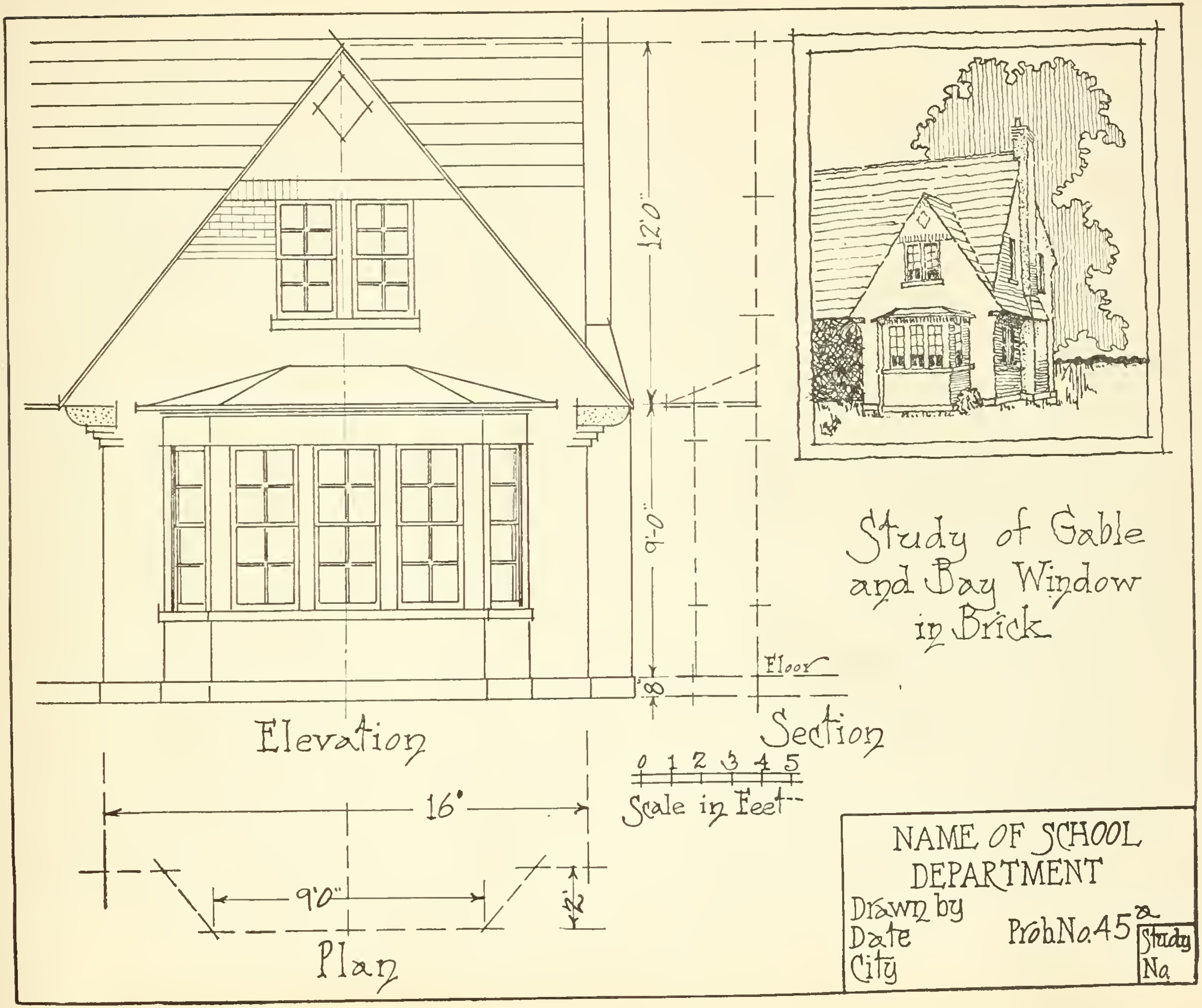
PROBLEM 45. STUDY OF GABLE AND BAY WINDOW IN BRICK

There is a warmth of feeling in a brick house which is attractive in itself. This does not relieve the designer from arranging and proportioning his house. Brick lends itself to the English style of house with a steeply pitched roof and low windows. Such a house shows individuality and well reflects the personality of the owner.

a. Complete the straight-line drawing as suggested. Dimension your drawing fully. Use a scale of $\frac{1}{4}''=1$ ft.

b. Work out the brick pattern completely. Remember that it is necessary for the pattern to finish symmetrically at the edges. If the first trial is not successful select another pattern and try again. This is valuable experience, but it requires patience do to the work successfully and well.

c. Make a drawing of the side of the house as shown in the sketch in the upper right-hand corner. Choose your own dimensions and scale.



Study of Gable
and Bay Window
in Brick

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Prob.No.45ª
Study
No.

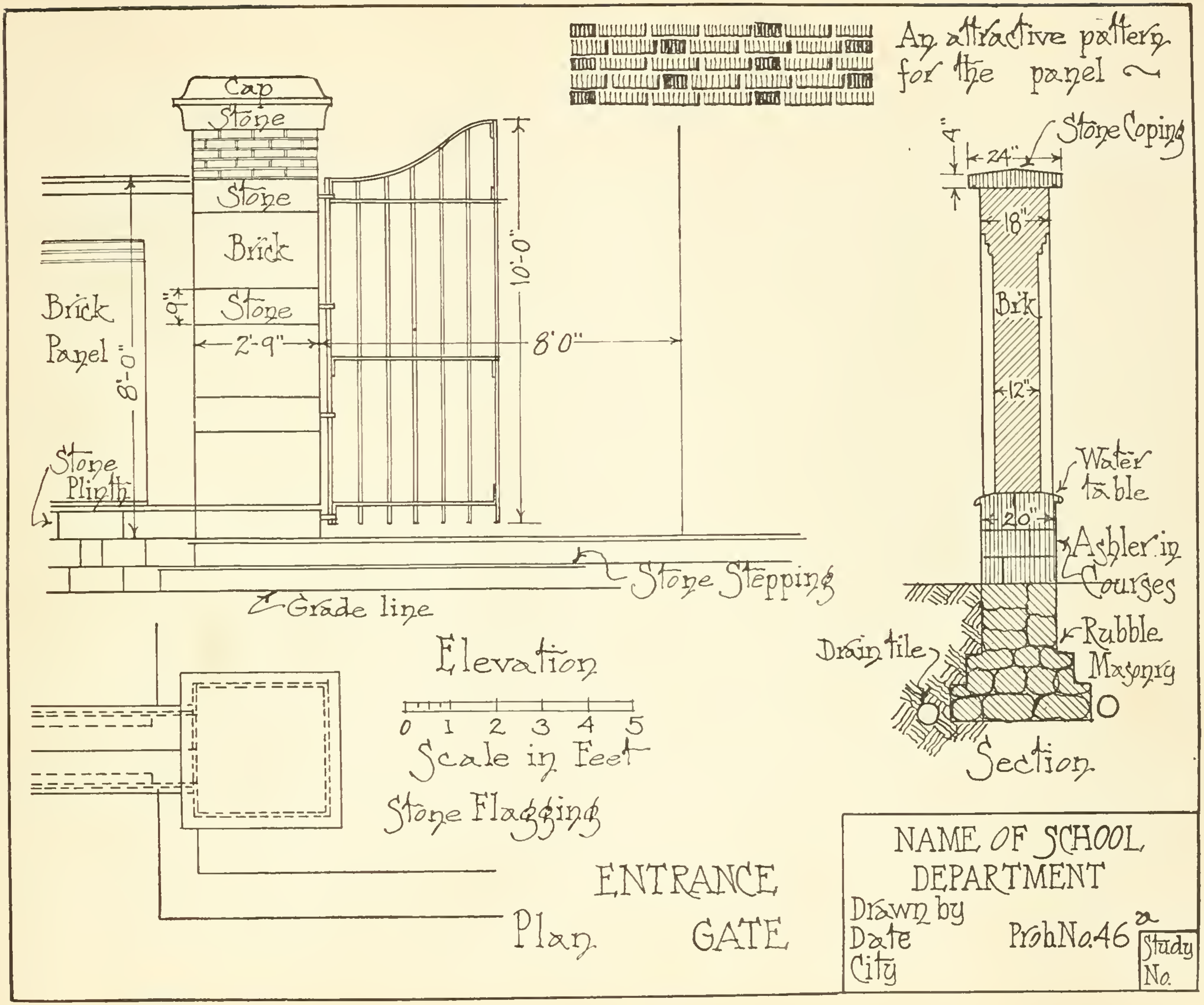
PROBLEM 46. ENTRANCE GATE

For a formal entrance to a country estate or to the grounds surrounding a town house nothing is more effective than brick piers and an iron gate.

a. Complete the straight-line drawing as shown. Make a plan, section, and elevation in full. Use a scale of $\frac{3}{8}'' = 1$ ft.

b. Work out the brick pattern in full for the above drawing.

c. Make a detail of the iron-work for the gate. Choose your own scale and dimension your drawing fully.


An attractive pattern for the panel
Cap
Stone
Stone
Brick
Stone
Brick Panel
9"
2'-9"
8'0"
10'-0"
8'-0"
Stone Plinth
Stone Stepping
Grade line
Elevation
0 1 2 3 4 5
Scale in Feet
Stone Flagging
Plan
ENTRANCE GATE
4"
24"
Stone Coping
18"
Brk
12"
Water table
20"
Ashler in Courses
Rubble Masonry
Drain tile
Section
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob.No.46 a
Study No.

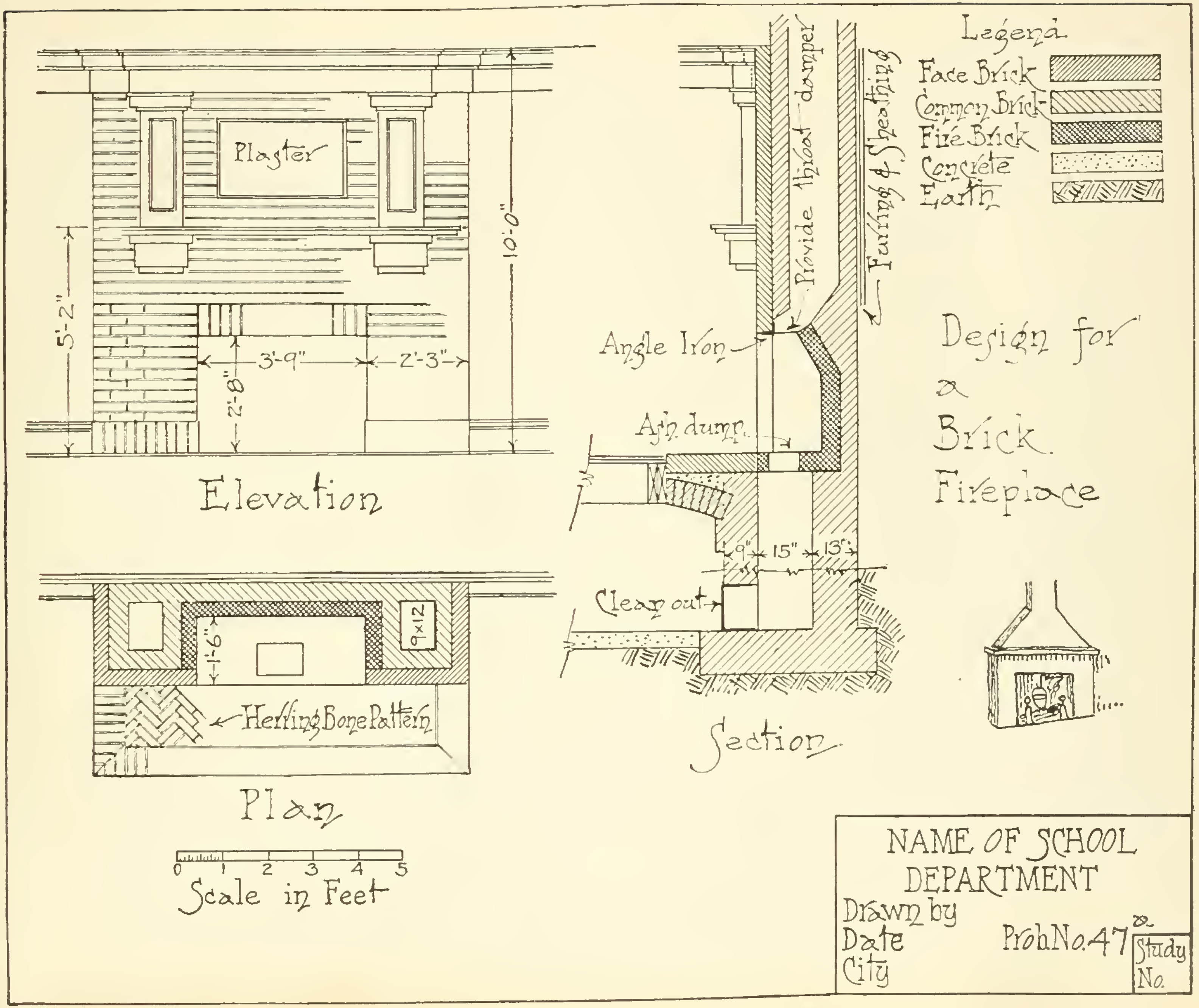
PROBLEM 47. DESIGN FOR A BRICK FIREPLACE

A fireplace in brick is pleasing in almost any interior. Care should be taken, however, to have it in proportion to the room in which it is placed. The fireplace shown here should not be placed in a small room. A massive frieze and ceiling beams would enhance the attractiveness of the room.

a. Complete the straight-line drawing as suggested. Use a scale of $\frac{3}{8}''=1$ ft. and dimension your drawing fully.

b. Work out the brick pattern completely to scale.

c. Make a drawing of a brick fireplace in accordance with your own ideas.


Plaster
5'-2"
10'-0"
3'-9"
2'-3"
2'-8"
Elevation
1'-6"
9x12
Herring Bone Pattern
Plan
0 1 2 3 4 5
Scale in Feet
Provide throat damper
Furring & Sheathing
Angle Iron
Ash dump
9"
15"
13"
Clean out
Section
Legend
Face Brick
Common Brick
Fire Brick
Concrete
Earth
Design for a Brick Fireplace
NAME OF SCHOOL
DEPARTMENT
Drawn by
Date
City
Prob. No. 47a
Study No.

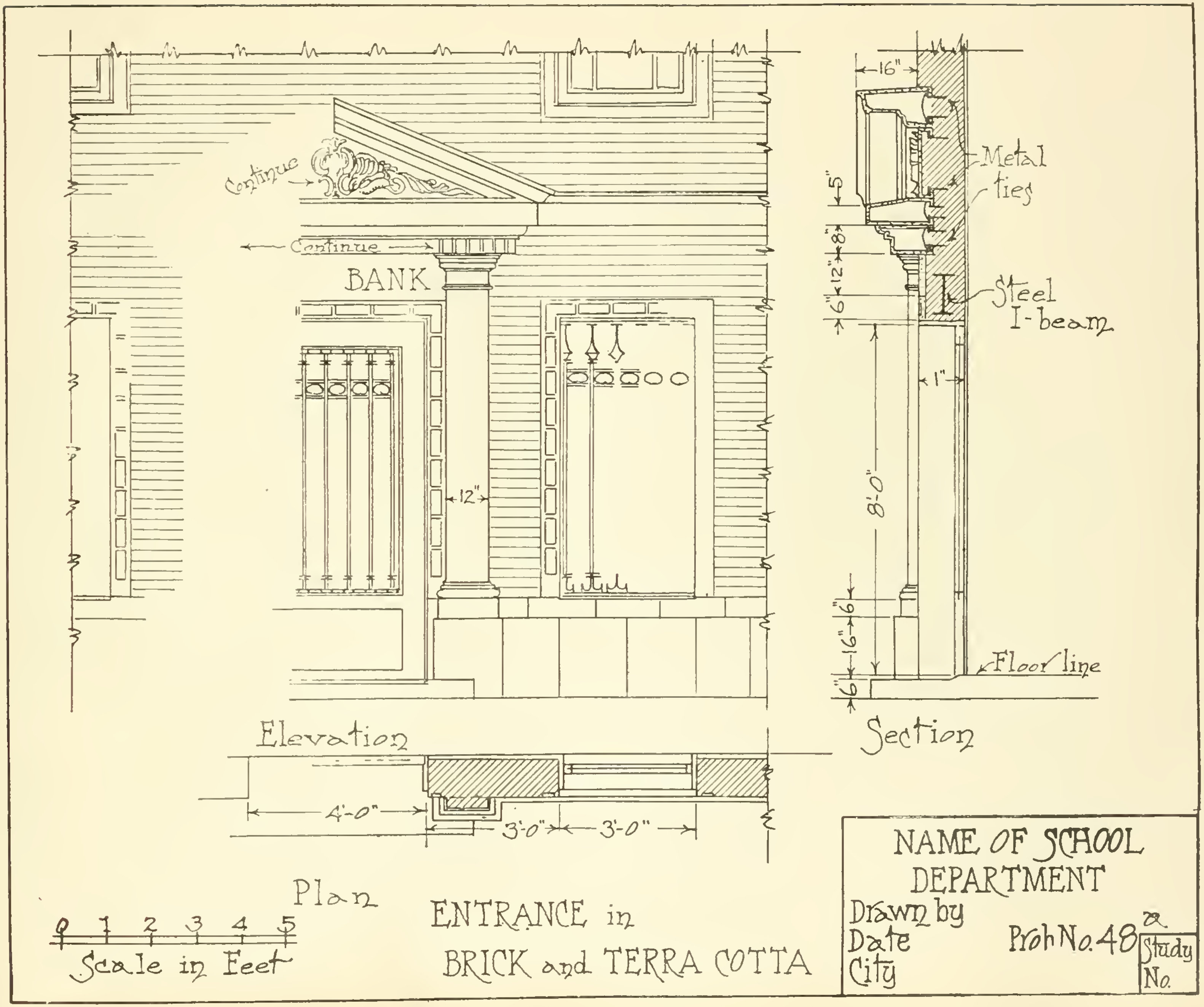
PROBLEM 48. ENTRANCE IN BRICK AND TERRA COTTA

Architectural terra cotta is largely used in connection with buildings of a public or semi-public nature. It is a particularly desirable material for this purpose as it is easily moulded into many beautiful shapes, may be given any desired color or texture and is everlasting. The material is made into blocks that are carefully fitted together and built into the wall or secured with metal ties.

a. Complete the straight-line drawing as shown here. Use $\frac{3}{8}''=1$ ft. scale.

b. Work out a suitable pattern for the brick-work.

c. Make a detail drawing of the ornamental iron-work for the door and windows. Choose your own scale and dimension your drawing fully.

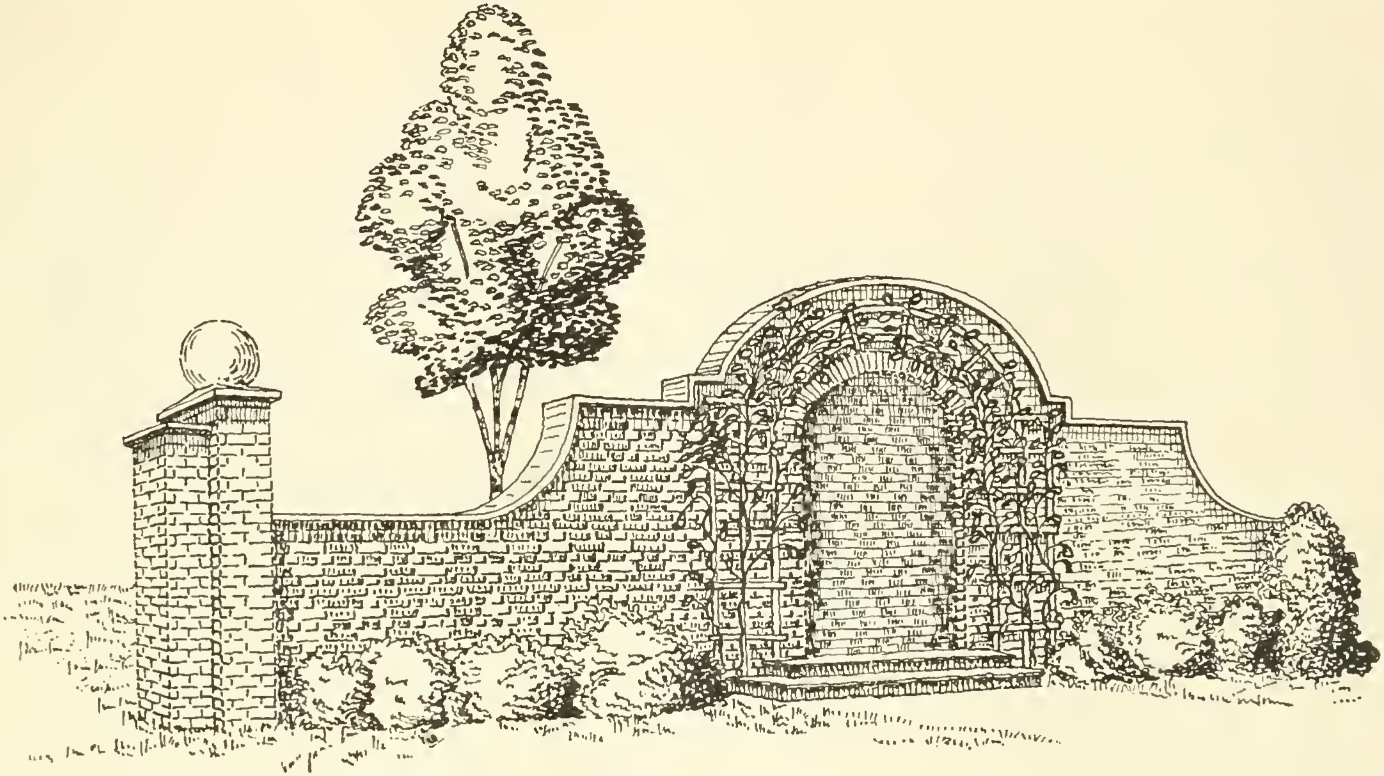

Continue
Continue
BANK
12"
Elevation
16"
Metal ties
5"
8"
12"
6"
Steel I-beam
1"
8'-0"
6
16"
6"
Floor line
Section
4'-0"
3'-0"
3'-0"
Plan
0 1 2 3 4 5
Scale in Feet
ENTRANCE in BRICK and TERRA COTTA
NAME OF SCHOOL DEPARTMENT
Drawn by
Date
City
Prob No. 48a
Study No.

PROBLEM 49. A BRICK GARDEN WALL AND NICHE

Brick lends itself to informal as well as formal designs. For the garden nothing can be more serviceable, permanent, or attractive than a wall of brick.

a. Heretofore the student has been given a suggestion as to how his straight-line drawing should look. He is now required to make a drawing with only a picture of the object to guide him. Make a complete detail drawing of the garden wall and niche and dimension it fully.

b. Lay out the patterns for the brick-work.



A Brick Garden Wall and Niche

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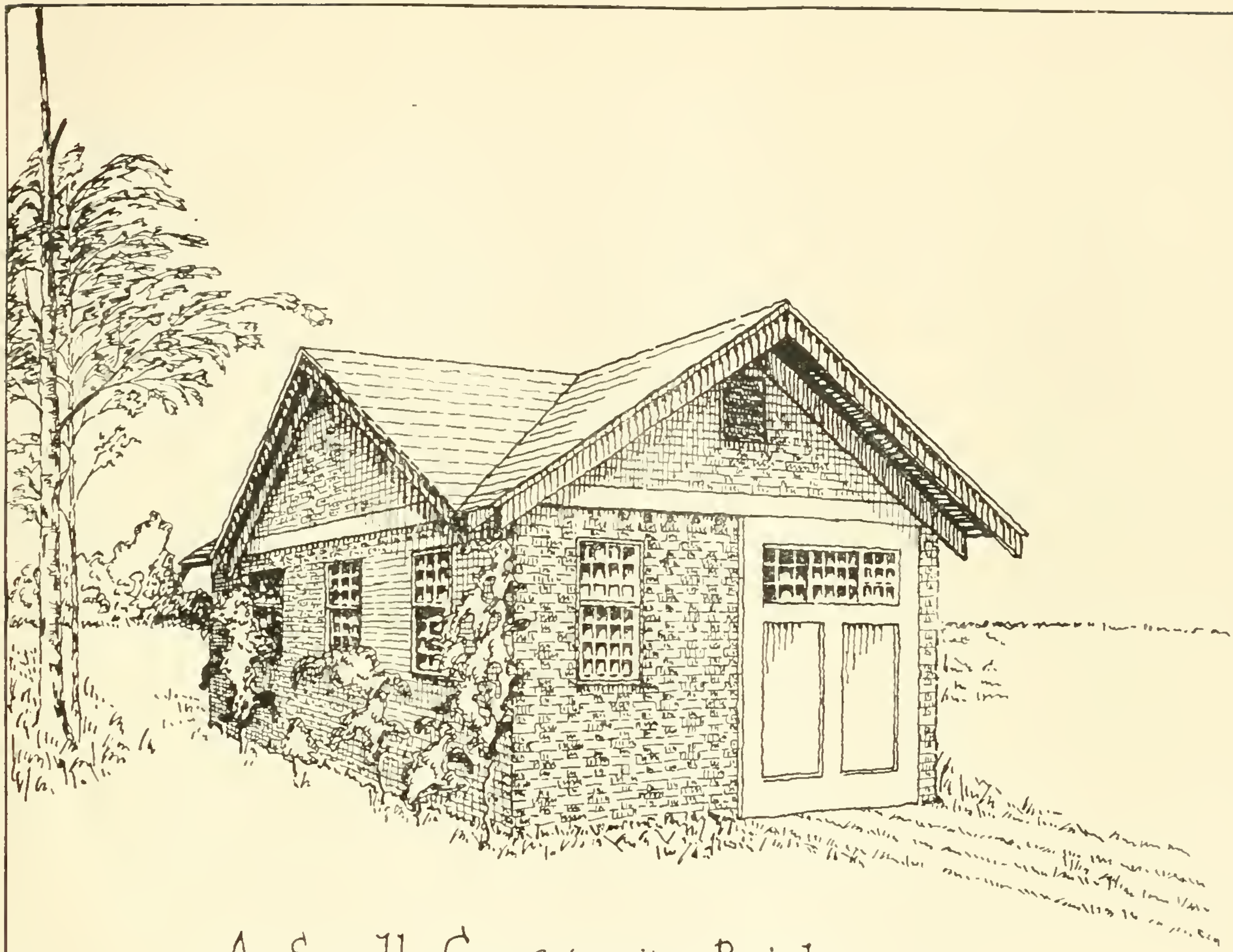
PROBLEM 50. A SMALL GARAGE IN BRICK

Brick is suitable for small structures as well as large ones. This garage is built of brick in an attractive design.

a. Make complete drawings for the garage, including plan and elevation. Work out the brick pattern. Choose your own scale and dimension your drawing fully. Use two or more sheets if necessary.



A Small Garage in Brick

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